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PROCEEDINGS OF

THE LINNEAN SOCIETY OF LONDON

159th Session (1946–47)

Vol. 159 Part 2

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This Journal, which was in abeyance during the war years, is again being published, and a new part (Vol. 5, No. 4) is in the press.

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PROCEEDINGS OF

THE LINNEAN SOCIETY OF LONDON

Session 1946–47

Vol. 159 Part 2

PROCEEDINGS OF THE GENERAL MEETING ON 20 March 1947

Professor G. R. DE BEER, F.R.S., President, in the Chair.

The Proceedings of the General Meetings held on Thursday, 20 February and 6 March 1947, having been circulated, were taken as read and confirmed.

The following were thanked for gifts made to the Library since the last Meeting :—Mr. C. McCann, The British Council, the Marine Biological Station, Millport, and the Swedish State Institute of Freshwater Fishery Research, Drottningholm.

The President reminded Fellows that under Bye-Law, Chap. 8, Sect. 2, Fellows are entitled to make recommendations for new Members of Council and Officers.

The President reported the deaths of Professor Ludwig Jost and Dr. Knud Stephensen, Foreign Members of the Society.

The following communications were read and discussed :—

ALGAL DISCUSSION.

This Discussion was arranged at the instance of the Marine Algal Committee with the generous co-operation of the Scottish Seaweed Research Association.

Professor L. NEWTON. The study of certain Red Seaweeds in relation to their use in Agar production.

Dr. MARGERY KNIGHT. An enquiry into certain aspects of Growth and Development of some British Fucaceae.

Dr. F. N. WOODWARD. Seasonal variation in chemical composition of the common British brown seaweeds.

Abstract.—

Accurate analytical methods have been developed for the determination of mannitol, alginic acid, laminarin and fucoidin in brown algae. These and other methods have been applied to samples of the common British Laminariales and fucoids taken at monthly intervals during the last two years, and the results analysed as far as is possible in the light of the evidence available, and compared with published data.

The trend of future research in this field under the aegis of the S.S.R.A. were indicated.

Mr. F. T. WALKER. Fucoid growth around the Scottish coast and related factors.

(In a general discussion, the following took part :—Mr. A. D. Cotton, O.B.E., the President, Professor Dame Helen Gwynne-Vaughan, G.B.E., Dr. J. Ramsbottom, O.B.E.) [Three of the papers printed in full, below.]

THE STUDY OF CERTAIN RED SEAWEEDS IN RELATION TO THEIR USE IN AGAR PRODUCTION

By LILY NEWTON.

Agar is an extract of certain red seaweeds, which dissolves in water and sets to a firm jelly. Before 1939 it was made chiefly in Japan from various red seaweeds, though America had a small production. Agar was used for a great variety of scientific, medicinal and commercial purposes before 1939. The food industry made considerable claims on the world's agar output from the point of view of canning ; the stiff gel held soft flesh and fish in the can without damage. On the scientific side agar was an indispensable medium for the growth of fungi and bacteria, having great advantages over animal gels. On account of the need for agar in the preparation of protective injections for the armed forces, it became clear early in the war that supplies were necessary in all the belligerent countries, and many attempts were made to utilize any weeds from which an agar could be made that were available locally. With the entry of Japan into the war the position became more acute and attempts to increase the supply are known to have been made in America, New Zealand, Australia, South Africa, Eire, India, Ceylon, Russia, China, Portugal, Spain, and Italy, as well as in Great Britain.

The degree of urgency, the availability of material and other factors dictated the extent to which the investigation of the autecology of the plants concerned could be carried out, but it is evident that many common problems have been faced by scientists working with different material in various parts of the world. To a large extent the controlling factor has been the facility with which weeds could be harvested and the amount of risk that was justifiable concerning the maintenance of supplies.

In Britain, though a stock of agar had been stored by the Government, it was deemed desirable to seek a local source of supply. The work was carried out, on behalf of the Ministry of Supply, by a team of workers, the chemical part being done by Drs. Marshall and Orr at the Marine Station, Millport. Miss E. A. Lewis was a full-time research worker at Aberystwyth, and sections of the work have also been undertaken by Mrs. Conway, Glasgow, Mrs. Wright Baker, Manchester, Mr. Carter, Aberystwyth, and a large number of other voluntary workers. Preliminary chemical and botanical investigations led to the conclusion that the red seaweeds *Chondrus crispus* and *Gigartina stellata* would be the best source of agar in this country, having regard both to the availability of the raw material and the suitability of the product. As a result, surveys of coastal areas in Britain were undertaken in order to ascertain where the plants grew in sufficient quantity to justify a harvest, and investigations were begun on the autecology of the plants themselves. At first, experiments and observations were carried out on both plants, but later when it was ascertained that only 5 per cent. of the total harvest would be *Chondrus* and that this proportion was also desirable from the point of view of the manufacturer, experimental work was confined mainly to *Gigartina*. The work is still in progress, but a satisfactory bacteriological agar has been produced and a certain amount of information on the autecology of the plants is available.

Coastal areas likely to yield harvestable quantities of weed were visited and were reported upon, or surveyed in detail, according to the amount they carried. At first the weight of weed in one square yard was calculated and a total arrived at for each area, but later, in the richer areas north of the Tweed, the weight per linear yard of shore was calculated. *Chondrus* and *Gigartina* were estimated together and the percentage noted of each. Harvestable areas were confined to the rocky areas on the west coast of Britain, except for one eastern area in Northumberland. The richest localities were the islands of the Clyde Sea area, though high yields were available in the Islands of Skye, Mull and Tiree, as well as in Anglesey, parts of Wales, Devon and Cornwall.

Gigartina stellata Batt.

The genus appears to consist of the type species and one variety, var. *acuta* Good. and Woodw. Turner's var. *prolifera* and var. *incurvatus* are believed to be only growth forms. Further taxonomic detail will appear when the work is published more fully.

New growth occurs in spring mainly from the basal hapteron and also from behind the edges of wounded thalli. The growth is soft and bright pink in colour, sometimes passing through an olive-green phase later, especially in the more southerly localities, and finally assumes the dark brownish-red colour which is characteristic of the cartilaginous adult thallus. When young the thallus becomes punctate, and excrescences develop which later bear spermatangia and/or cystocarps.

When the thallus is young a transverse section shows that the cortical layer consists of from 4–5 cell rows (in April for example); by September the number has increased to 10, the cell-walls increase in thickness and the secondary pore-connections of the inner cortex and medulla become more numerous. These anatomical changes can be correlated with the seasonal increase in the gel strength of the extract, a matter of major importance in agar manufacture.

It has been ascertained, by marking plants and by examination of the hapteron, that the plants are either annuals or pseudo-perennials. Examination of the hapteron shows that regeneration takes place from the surface layer or from a lower layer which has been covered by a later year's growth. In other rarer cases the hapteron consists only of one layer and these plants, which occur in shallow shingle pools, have been observed to be washed away completely at the close of the season. The fact that new fronds are freely produced by the haptera is of importance from the harvesting point of view.

On account of the national emergency and the nature of the problem, it was considered of major importance to investigate first the growth and regeneration of the plant. A cytological study, which it is hoped will elucidate the life-history, is being carried out by Mrs. Baker of Manchester, with the help of Miss Gonzalez. Spermatangia are readily seen on the thalli or on linear excrescences, and carpogonial branches develop in the excrescences arising on the thallus. A spermatium has been seen attached to a trichogyne. Fertilization presumably occurs, though it has not yet been seen, and carpospores are formed which are shed from the cystocarp through a lateral ostiole. The cystocarps reach a peak of maturity in July and August and the maximum period of spore-discharge appears to be from September to December. No tetrasporangial plants have ever been identified. Attempts have been made to grow the spores both in culture and under various conditions in the sea and it is evident that there is a recolonization sequence and that the spores do not grow readily on bare rock surfaces. This, together with other results, indicates that *Gigartina* cannot easily withstand desiccation. It has an important commercial application in that it shows that the methods of culture on prepared substrata put into the sea that have been used commercially by

the Japanese and others for *Porphyra* and *Gracilaria*, would not readily be applicable to the present problem. The spores are very intolerant of many chemicals and the sterilization of cleared areas has had to be by means of a deckscraper and/or a blow-lamp.

The study of the ecology of *Gigartina* has shown that it occurs in well-aerated water, free from mud, on exposed or semi-exposed coasts, near low water-mark of spring tides, at the base of the *Fucus serratus* zone, either in discontinuous tufts on rocky boulders or forming an almost continuous belt, sometimes as wide as 20 yards. When growing luxuriantly in a wide belt, it is very often associated with *Himanthalia lorea*. There is some evidence of its tolerance of water of relatively low salinity and high bacterial count, indicating a measure of sewage pollution. At the limits of its up-shore range, poor plants may occur beneath the thalli of the larger *Fuci*, but weeding out the latter only leads to the deterioration of the plants and was not considered desirable from a commercial point of view.

There appears to be no general correlation between geological strata and the occurrence of *Gigartina* except in so far as the nature of the strata influences the configuration and topography of the shore in the lower-littoral zone and the form of the surface in relation to its suitability as a place of lodgment for the spore. This is particularly well seen in dealing with the distribution in the western isles of Scotland and especially in comparing the distribution in the inner and outer Hebrides.

The prevalence of exceptionally high winds and heavy seas appears to be a deterrent to the presence of *Gigartina*, and there is some evidence that the plant can occur higher up-shore in regions where the low-water of spring tides is in early morning and evening, and the period of maximum exposure never occurs in the hottest part of a summer day. This is further evidence for the suggestion that *Gigartina* is intolerant of desiccation. Observations have been made on the associated fauna and especially on the limpets which eat out ' glades ' in otherwise closed *Gigartina* communities.

Experimental work on growth and regeneration was carried out to decide the time when a harvest might safely be taken without endangering future supplies and to determine the best dates and manner of gathering. Temporary arrangements were made in the early years of the war, but on the results of numerous experiments it was decided to take only *one* harvest each year, from the first available tide in July to the last available tide in September. As a result of experiments on the method of harvesting, instructions were given that the material should be hand-picked and not sheared, and that care should be taken not to destroy the holdfast. An illustrative example showing the effect of good and bad picking showed also that the seasonal growth reached a peak in summer, and the harvesting period decided upon ensured the maximum weight of the plant. Correlation with the gel-strength curves led to the same conclusion regarding the dates of harvest. The gel-strength of the extract, the thickness and the number of the cortical walls, thus all reach a maximum when the plants reach their reproductive peak and the spores have to be developed and fed. Harvesting ceased at the time of maximum spore discharge and incidentally at a time when seas tended to be rough, but it was hoped that enough spores would be available from inaccessible plants to continue the perpetuation of the plant by that means. The preservation of the holdfasts by careful harvesting ensured regeneration from them.

No harvesting of driftweed was ever allowed because it was determined, by soaking in water, that drift plants of *Gigartina* had lost some of their gelling-capacity.

The actual harvesting was carried out by voluntary workers from all walks of life in England and Wales. In the richer areas of the Clyde the plant grows more profusely and harvesting could be planned on a commercial basis, and

a drying station set up. It is in that area that post-war commercial harvesting is established.

Chondrus crispus Lyngb.

The study of *Chondrus* was much less intense than that of *Gigartina*, and it took a secondary place when it was realized that the harvest would be 95 per cent. *Gigartina*. *Chondrus* plants are much more easily torn away completely by careless harvesting than those of *Gigartina* and as a result considerable harm to future crops can easily be caused. Unlike *Gigartina*, *Chondrus* has a life-cycle which is well known ; the sexual plants bear cystocarps in summer and the diploid plants bear tetraspores mainly in winter. Research is in progress to ascertain whether in this case reproduction is correlated with an increase in the gel strength of the extract of the two types of plant.

The chemical investigations of Marshall and Orr have led to the production of a satisfactory bacteriological agar by a method which is protected by British patent. *Gigartina* agar has a lower melting-point and dissolves much more readily than Japanese agar. Since the melting- and setting-points of *Gigartina* agar are affected by the presence of electrolytes, certain modifications of bacteriological technique are sometimes necessary when the media used contain inorganic salts. It is, however, suitable for all ordinary routine bacteriological work.

A fuller account of the botanical and chemical work will be published elsewhere.

A BIOLOGICAL STUDY OF FUCUS VESICULOSUS AND FUCUS SERRATUS

By Margery Knight.

In the course of an investigation, originally inspired by the Ministry of Supply, an opportunity offered itself for continued observation of certain genera and species of common occurrence in the algal flora of the British coasts. Quite apart from the data required for specific reasons by the Ministry, certain biological facts revealed themselves, which, taken together, make a considerable addition to knowledge of algal life, and are capable of application to the wider field of general problems of growth and behaviour.

The original purpose of the enquiry was to determine growth rate and longevity of a number of algae. Three stations were used as observation areas : the coast of Devon, the Isle of Man and a station on the west coast of Argyll.

The first point which attracted attention was the spatial distribution of the fucoid zone on the three areas in relation to tidal levels. The general facies of the zones and the order of succession of their components from upper to lower levels agreed in the three areas but the bathymetric level of the zone as a whole varied from area to area. It was a little difficult to correlate the tidal zones in the three areas. They differed in tidal range and in the time of incidence of low water of deep spring tides. These factors, together with meteorological differences in the stations, combine to bring about a general depression of the fucoid zone on southern shores compared with more northerly areas.

An appropriate datum for comparison was provided by ' mid-tide level', defined as the level of the tide at a point in time midway between high and low tide, and roughly equivalent to Mean Sea-Level. The assumption that this line was equivalent in all three areas is reasonably justified by a calibration of the shores which showed that the movement of the tides on all three shores

approximated to simple harmonic motion. Using mid-tide level as a criterion, it was found that the *Fucus vesiculosus* zone and the *Fucus serratus* zone below it came wholly below mid-tide level on the Devon coast. The result of this disposition, or perhaps more accurately the cause of it, was that both zones experienced longer periods of submergence than of exposure to air. Mid-tide level in the Isle of Man runs across the junction of the two zones, so that *Fucus vesiculosus* has greater periods of exposure than of submergence, and the converse is true for *Fucus serratus*. The upper part of the fucoid zone thus appears to emerge from the sea for longer periods with increasing latitude. This hypothesis was confirmed by observation of the Scottish coasts. In similar manner the lower limit of the zone, marked by the junction of *Fucus serratus* with *Laminaria digitata*, shows the same progressive uplift with increasing latitude. On the Devon coast, *Laminaria digitata* scarcely emerges from the sub-littoral zone and is reachable from the shore only at deep spring tides. In the Isle of Man it emerges at low water of all tides and rises still further on the coasts of Argyll.

The factors controlling such bathymetric variation may be grouped together as the factor of ' exposure ', but it is clear that light intensity, seasonal mean air temperatures, range of temperature variation and humidity values are all concerned and any one of them may operate as a determining factor.

In observing growth rate of the individual zones certain general features were clearly marked. The upper fringes of each zone were characterized by relatively short plants in dense concentration. The most luxuriant plants were in the middle of the zones and the lower levels show loss of stature and relatively few young sporelings. Two factors oppose one another in bringing about this size distribution. Better illumination of the upper zones facilitates germination and establishes large numbers of small sporelings. This is strikingly shown by counts of sporelings on square metres of surface at different levels within the zone. They normally reach thousands per square metre and a maximum count of 16,000 sporelings per square metre has been recorded for the upper level of the zone. These sporelings are, however, arrested at an early stage and their further growth is limited by other components of the exposure factor. In these circumstances it is clear that the assessment of age by stature and stage of development is not justifiable in the upper levels of the zone, where growth rate is reduced with rising level until it reaches a condition of stasis in the uppermost levels. This arrest of growth inhibits increase in length but permits of a slow increase in the diameter of the stipe.

That this arrest of growth has not necessarily impaired the vitality of the plants has been shown by ' transfer ' experiments in which plants in an apparent sporeling stage of development, but known to have persisted for four years, were transferred to a lower level on the shore. When this was done they were released from the inhibiting influence and regained their capacity for thallus elongation.

The general course of the growth curves for both *Fucus vesiculosus* and *Fucus serratus* show the same form. Elongation and repeated forking result in a flat frond of quadrilateral outline with one sharp angle Its average length at the end of a year's growth varies from area to area. In general, the highest rate of growth was shown by the Scottish plants, but the rate is subject to variation within each area according to local differences. Exposure to wave-action causes such extensive breakage of foliage that a whole population of plants on a shore facing the direction of prevailing winds may be noticeably shorter than that on a coast with some shelter from the roughest water.

The second and third years of the plants' life mark the grand period of growth during which the plants increase not only in length but also markedly in bulk, increasing from an average weight of an ounce or two at the end of their first year to several pounds at the end of three years. The original a frond is replaced by a plant of bushy habit.

With increase in size and weight, the leverage exerted by wave-action operates more strongly and the depletion rate for the plant population rises steeply. Only a small proportion of an original population survive into the fourth year and it is doubtful if more than a very few individuals survive beyond this point.

The two species have many features of behaviour in common but they also show striking differences.

At each dichotomy of the frond, with the possible exception of the first, the two arms of the fork show unequal potential power of elongation. If successive dichotomies on a plant are observed, it can be seen that the superior growth-potential shows rhythmic alternation from one side to the other, giving a zig-zag course to the direction of the main frond. This alternation is clearly fundamental to the fronds of both species. Though a habit of dichotomous branching is usually ascribed to British species of *Fucus*, it is doubtful whether the definition in its strictest sense is applicable. In neither of the species under consideration is the apical cell divided into two equal halves, but a segment is cut off in the normal way on one side or the other of the apical cell, and its bulk by no means equals that of the remainder of the apical cell. This segment, which is destined to produce the second arm of the fork, appears to inherit with its relatively smaller bulk a smaller capacity for the promotion of tissue-formation, and the frondage to which it gives rise cannot keep pace with that formed by the activity of the parent apical cell. Presumably the next 'apical' segment from the original apical cell will be cut off on the opposite side.

When the period of reproduction approaches, those parts of the frond destined to bear receptacles are already delineated by their repeated dichotomies at short intervals, compared with the longer internodes of the vegetative 'leaders'. The fruiting fronds lose the inequality of forking and appear as fans with their tips lying on the arc of a circle. The overgrowth of the leaders leaves the reproductive fans in a pseudo-lateral position in *Fucus vesiculosus*, but the distal parts of the frond becomes reproductive in *Fucus vesiculosus* and further extension of the thallus is secured by the later activity of vegetative apices in a proximal position. In both species, secondary leaders are developed from a few early dichotomies.

The difference in behaviour of the two species affects the ultimate form of the plants, especially in the later years of life.

Fucus vesiculosus grows longer and longer, the vegetative leaders stretch out continuously, leaving successive pseudo laterals behind. *Fucus serratus* develops vigorously, growing distal fans which become receptacular and are ultimately shed, to be replaced by the up-growth of new fronds by acceleration of the growth of vegetative apices from below. The steady elongation of *F. vesiculosus* is replaced in *F. serratus* by an intermittent elongation.

The process of receptacle formation is protracted. Three months separate initiation and maturation of the receptacles, and after release of the gametes receptacular tissue gradually decays. Receptacle-formation follows the same slow process in both species but the incidence of fruiting in the two species is separated by an interval of several months. The duration of the period of fruiting over the plant population as a whole is much longer for *F. serratus* than for *F. vesiculosus*.

Receptacle-formation is at first associated with the activity of an apical cell. The apical groove remains for some time but is flattened out and disappears before the receptacle is half grown, and the apical cell ceases to function. This cessation of cell segmentation with the onset of gamete formation is the culmination of a retardation process shown much earlier in the slower rate of growth of what are destined to be receptacular fans, compared with the vegetative apices. This correlation of restricted apical segmentation with gamete formation is especially clear in *Fucus vesiculosus*.

Deterioration of the receptacle follows release of the gametes and is transferred to subtending fronds until all frondage which has fruited is cut off. The process of necrosis proceeds basipetally over successive forks and is arrested only at the junction of two arms, one of which is still provided with a vegetative apex. This remote control of tissue 'tone' by a living apical cell is a very clearly marked feature of the plants and is a little unexpected in an alga.

The effect of frond depletion on the form of the plants varies in the two species according to the different positions of the reproductive fans. *Fucus vesiculosus* is reduced to a long thin 'string' with small spines or bosses marking the points of abcission of fronds, and ends in a terminal growing point capable of producing new frondage distally. *Fucus serratus* loses frondage distally and the scars are hidden by the up-growth of new frondage from below. As the plant grows older, latent apices at successively lower levels are exploited, and in point of fact each new set of frondage fails to reach the length of its predecessor. The logical end to such a process, always supposing the plant survives the vicissitudes of life on a seashore, is reached when the most basally placed apices have been developed and the plant is reduced to a thick rugose stipe with no apex left for further development. *Fucus vesiculosus*, on the other hand, is theoretically capable of unlimited elongation.

The latency of apices of *Fucus serratus* with a basipetal gradient, and the clear evidence of remote control of active apices on local development of the plant body, suggests that in even so lowly an organism as a member of the Phaeophyceae a profitable field of study of growth hormones might be found.

A SEAWEED SURVEY OF SCOTLAND—FUCACEAE
(April 1945—December 1946)

By F. T. Walker.

(With 5 text-figures.)

Introduction.

A survey of the seaweed resources of Scotland is one of the major undertakings of the Scottish Seaweed Research Association, and towards implementing this a survey of the littoral zone of the coast was started in Arpil 1945 and completed in December 1946.

The length of the coast of the Scotish Mainland and Islands, excluding Shetland and the minor islets and inlets, is 4,630 miles by our measurements. Of this distance 4,250 miles (92 per cent.) have been surveyed. The unsurveyed 8 per cent. includes the islands of Barra, Jura, Tiree, Coll, Rum, Eigg, Muck, Canna and Rona (Hebrides), Graemsay, Flotta and Wyre (Orkney), Loch Nevis and Loch Hourn (Inverness-shire).

Survey Methods.

For the purpose of the survey, the coast was divided into areas, determined chiefly by geographical considerations, and a preliminary survey and report made of each.

From the results of a preliminary survey, it was decided whether further surveys—general and detailed—were warranted.

As a guide, although by no means a rigid one, general surveys were made in sub-areas where the density of weed growth was 50–100 tons/mile and detailed surveys where it was over 100 tons/mile.

Areas worthy of detailed survey were divided into sub-areas in most cases, and these in turn into sections. A section was determined by changes in width, substratum, weed density, species, zonation, etc., thus to ensure more accurate assessment.

The length and width of the weed zone of each section was measured ; the species present were noted and their relative areas of growth estimated if represented by 5 per cent. or more of the whole ; the average density of growth was obtained by cutting and weighing the weed within chosen quadrats, where

MAP 1.—Scotland. Showing all areas worthy of general surveys ////// 50–100 tons/mile or detailed surveys ▮ 100 tons/mile. The figures give the weed density in tons/acre for the Mainland, Mull and Arran.

weed cover was representative of the whole section. (The weed within the quadrat—not whole plants whose holdfasts were within the quadrat—was cut for weighing.)

The zone of *Pelvetia* at or near H.W.M. was not included in the areas and quantities of the weed zones. This species usually presents a scattered growth,

and while the area over which it grows may be considerable, its density is very low and, therefore, disproportionately reduces the weed density of an area.

The measurement of the weed zones was carried out between ebb and flood tides, starting and finishing respectively when approximately two-thirds of the *Ascophyllum nodosum* zone was uncovered.

The floating fronds of this species, while the zone is partly under water, enable assessments to be made of the extent of the weed, but the zone of *Fucus serratus* at or near L.W.M. is not included in the estimation of area and quantity unless low water conditions allowed. The quantity of *Fucus serratus* must consequently be considered as a conservative estimate in this survey.

MAP 2.—Skye. Showing general surveys ▨ 50–100 tons/mile and detailed surveys ■ over 100/mile. The figures shown give the weed density in tons/acre.

To assess the accuracy of the survey methods, Airds Point, near Port Appin, was quantitatively surveyed separately by three of the botanical team during April, July and September 1945. The result showed the methods to be accurate to ± 5 per cent.

General observations were recorded for each section, *e. g.* formation of shore and hinterland, nature of substratum, exposure, accessibility, transport facilities, roads and tracks, population, attitude of crofters to weed collection, cast weed, local uses of weed, recolonization, presence of sub-littoral weed beds and other useful information.

In the surveys of North Uist, Benbecula, South Uist and the Islands in the Sound of Harris, the acreage of a sub-area, excluding areas of mud and sand, between H.W.M. and L.W.M. O.S.T., was measured from 6″ Ordnance Maps and the mean width of weed zone, weed density, weed cover and ratio of species, found by surveying, applied for the assessment of total weed growth. Over these areas, which are extensive—for they include many inlets, islets, skerries and very large boulders, the weed growth is relatively uniform.

MAP 3.—Orkney. Showing general surveys ////// 50–100 tons/mile and detailed surveys ■ over 100 tons/mile. The figures shown give the weed density in tons/acre.

Conditions of time and tide did not permit of detailed measurements, such as were made in the less extensive areas.

The two methods of detailed survey assessment have been carried out fo East Loch Roag and the Head of Loch Seaforth in Lewis, covering 4,400 ton

of littoral weed extending along 26 miles of coast. Comparison of the results show very close agreement, in fact, the results by acreage assessment can be considered more accurate for they include the zone of *Fucus serratus* not always exposed in some sub-areas where actual measurements of the width of the weed zone was made.

MAP 4.—Outer Hebrides. Showing general surveys ▨ 50–100 tons/mile and detailed surveys ■ over 100 tons/mile. The figures shown give the weed density in tons/acre.

Results of Detailed Surveys.

Of the 4,250 miles of coast surveyed, 540 miles (12 per cent.) of the whole coast of Scotland and Islands support weed with a density approaching or over 100 tons/mile, made up as follows :—

	Tons	Miles	Acres	Density tons/acre
Outer Hebrides	125,136	224	3,500	36
Inner Hebrides	8,263	60	278	30
Orkney Islands	38,774	199	1,813	21
Mainland, W. and N.W	8,540	57	356	24
Total	180,713	540	5,947	

It will be seen that the Outer Hebrides support 70 per cent. of the littoral seaweed of Scotland with the highest weed density and the Orkney Islands support 22 per cent. with lowest weed density. The remaining 8 per cent. is distributed on the Mainland (W. and N.W.) and the islands of Skye, Mull and Arran, where the weed densities are intermediate.

The coasts of the N.E. and E. Mainland do not support weed growing at a density approaching 100 tons/mile.

The marine algae of the littoral zone of Scotland are dominated by the *Fucaceae* and of this family, *Ascophyllum nodosum* is the predominating species in almost all sub-areas, with *Fucus vesiculosus* as second best, particularly in the Orkney Islands. Other species much in evidence are *Fucus spiralis*, *F. serratus*, *Pelvetia canaliculata*. *Ascophyllum Mackaii* occurs in specific places and *Fucus ceranoides* where fresh water flows into seawater.

The areas supporting the various species of *Fucaceae* are related as follows, taking *Ascophyllum nodosum* equal to 100 as an arbitrary standard :—

	Ascophyllum nodosum	*Fucus vesiculosus*	*F. spiralis*	*F. serratus*	*A. Mackaii*
Outer Hebrides	100	8	7	3	—
Inner Hebrides	100	20	—	1	8
Orkney Islands	100	83	31	43	—
Mainland, W. and N.W.	100	32	3	14	3
Scotland as a whole	100	32	13	15	<1

Maps.

No. 1 shows the location of *all* sub-areas found worthy of general and detailed surveying.
The weed densities for sub-areas given detailed surveys on the Mainland, Mull and Arran are also shown. Weed densities are lowest in the Solway Firth, but increase towards the N.W. Mainland. In the north and north-west of the Mainland, the weed growth is confined to the deeply indented sealochs and in the south to such areas which are sheltered from the Atlantic waters by the configuration of the land. Similar conditions apply to the weed-bearing areas of the Isle of Mull. The E. and N.E. Mainland supports no littoral weed.

No. 2 shows the sub-areas given general and detailed surveys in the Isle of Skye. The weed densities for the sub-areas given detailed surveys are also shown. These densities are of the same order as those for the N.W. Mainland and the Isle of Mull.
The weed-bearing areas are found along the sides of the deep sealochs around the island wherein shelter is obtained.

No. 3 shows the sub-areas given general and detailed surveys in the Orkney Islands. The weed densities for the sub-areas given detailed surveys are also shown. These densities are low and of the same order as found on the S.W. Mainland (Solway).
The weed grows along areas of the coast protected from the direct action of the Atlantic.

No. 4 shows the sub-areas given general and detailed surveys in the Outer Hebrides. The weed densities for the sub-areas given detailed surveys are also shown. These densities include the highest on record for Scotland. The densities recorded for Isle of Lewis and Harris are of the same order as found on the N.W. Mainland but, in the Islands of North Uist, Benbecula and South Uist, the weed is found growing at its best. Numerous skerries and shores of large boulders increase the acreage for weed growth.
Loch Maddy in North Uist supports the largest quantity—equal to the whole of Orkney—with the highest weed density of all places in Scotland—four times that of Orkney.
Little weed is found on the west of the Outer Isles, which meets the full force of the Atlantic, except in Loch Roag, sheltered by the Island of Great Bernera.
Well over half the littoral weed found in Scotland grows in the extensive sealochs on the east coast of the Outer Hebrides.

Almost all the weed recorded in this survey is found on three geological formations :—

70 per cent. on the Archean of the Outer Hebrides.
22 per cent. on the Old Red Sandstone of Orkney.
4 per cent. on the Tertiary of Skye and Mull.

Let us look at the complete survey shown in Map 1.

The Atlantic waters approaching Scotland rise and first break on the steep cliffs and sandy beaches of the western coast of the Outer Hebrides.

This rising of the Atlantic waters brings up salts, and the breaking of the swell and waves aerates the water. Weed cannot grow along this coast unless shelter is provided from the force of the Atlantic. Loch Roag is the only area on the west of the Outer Isles which has some degree of sheltered conditions.

But the turbulent waters sweep round the Hebrides and feed the sealochs bordering the Minch, wherein shelter is found and where weed grows in great profusion.

The Atlantic waters move along the north coast of the Mainland and weed is found only where shelter is provided by the deep indentations of the coast. Then on to Orkney, whose channels between the islands may be considered as sealochs ; weed grows in Orkney where shelter prevails.

On the N.E. and E. coast of the Mainland sealochs do not occur. The coast is either one of extensive stretches of sand or vertical cliff, and neither formation is suitable for good seaweed growth.

The general picture we wish to present is one of weed growth in areas fed directly by the Atlantic but sheltered from its violence.

Seasonal variation.

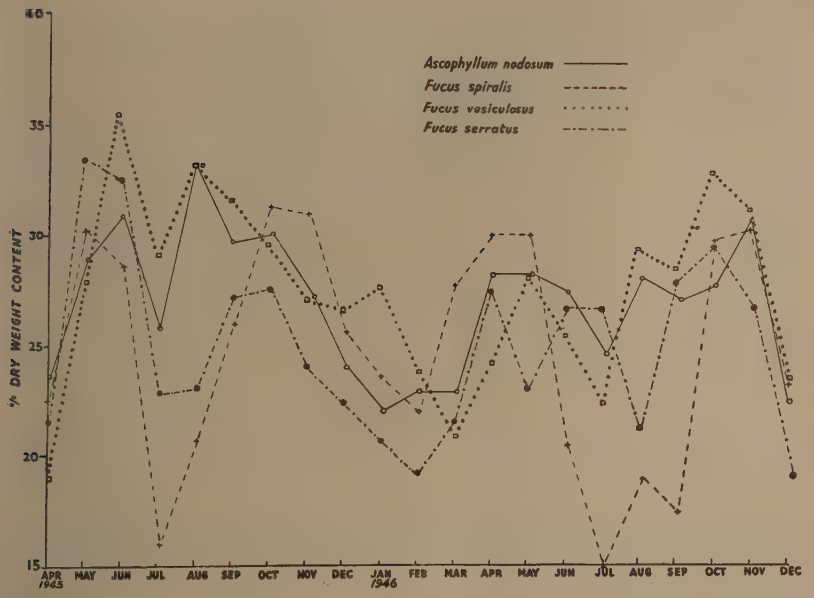
During the period of the survey, April 1945 to December 1946, the five chief species of the Fucaceae, found around the coast of Scotland and Islands, were cut monthly from the same area, namely, near Port Appin, Argyllshire, and their dry weight content determined.

This area is subjected to conditions of moderate exposure.

Ascophyllum nodosum was also cut monthly from areas subjected to conditions of exposure and shelter, Cullipool and Loch Melfort, Argyllshire, respectively, and their dry weight content determined.

The monthly seasonal variation, found near Port Appin, of the dry weight content expressed as a percentage of the fresh weight for the four chief species of Fucaceae which make up the weight of seaweed recorded in this survey, is indicated in Graph 1.

Each species rises and falls twice each year. It will be recalled that the diatom cycle rises and falls twice each year.



GRAPH 1.—Seasonal variation of the dry weight content of the chief species of the Fucaceae of Scotland. Expressed as a percentage of the fresh weight over the period April 1945 to December 1946.

The average monthly percentages for the five species are as follows, and it will be seen that no great difference is found in the percentage of their dry weight contents.

	Pelvetia canaliculata	*Fucus spiralis*	*F. vesiculosus*	*F. serratus*	*Ascophyllum nodosum*
April 1945 to March 1946	28·62	25·30	27·56	24·67	26·63
Jan. 1946 to Dec. 1946	26·93	23·93	26·25	24·05	25·64

But the fresh weight, over the period of the survey, of the five species of Fucaceae showed considerable difference. Taking *Ascophyllum nodosum* equal

to 100 as an arbitrary standard, the ratio of the average and range of fresh weights were :—

	Ratio of Average Fresh Weights	Range of Fresh Weights
Ascophyllum nodosum	100	±33 per cent.
F. vesiculosus	38	±30 per cent.
F. spiralis	39	±60 per cent.
F. serratus	51	±44 per cent.
Pelvetia canaliculata	35	±40 per cent.

If this ratio of weights found near Port Appin is applied to the areas of species above, the results approximate the density of weed growth per acre found in the survey. Thus density of weed growth is largely the result of species present. From this we may infer that plant growth is relatively constant in those areas of Scotland where weed is found in quantity.

The average monthly dry weight percentages for *Ascophyllum nodosum*, growing in varying positions of exposure, were found to be :—

	Sheltered	Moderately Exposed	Exposed
April 1945 to March 1946	28·37	26·63	26·79
Jan. 1946 to Dec. 1946	28·33	25·64	27·73

The ratio of the average and range of fresh weights, during the period of the survey of *Ascophyllum nodosum*, were :—

	Ratio of Average Fresh Weights	Range of Fresh Weights
Sheltered	86	±44 per cent.
Moderately Exposed	100	±33 per cent.
Exposed	90	±32 per cent.

The results of the survey must therefore be considered in the light of the seasonal variation.

The foregoing results summarize the data obtained from surveys carried out by members of the botanical team of the Scottish Seaweed Research Association as follows :—

North Uist, Benbecula, South Uist, Outer Hebrides.
F. T. Walker ; November 1945–November 1946.
West (northern half), North and East Mainland ; Islands of Skye and Mull.
Dorothy C. Gibb ; April 1945–May 1946.
West (southern half) Mainland ; Islands of Arran, Bute, Islay, Roasay, Harris and Lewis (excluding Loch Roag), Hebrides.
Margaret McLean Smith ; August 1945–December 1946.
Orkney (16 islands) ; Loch Roag, Lewis, Hebrides.
Emily Clay ; October 1945–December 1946.

A complete record of the data of the survey will be published later.

The interest shown and advice freely given by Mr. A. D. Cotton is gratefully acknowledged by the author, who was responsible for the organization of the survey.

Permission of the Director of S.S.R.A. to present this summary of the survey is also duly acknowledged.

The PRESIDENT expressed his keenest interest in the communications made by the four speakers. He pointed out that the Linnean Society consisted of zoologists as well as botanists, and he felt that it was the zoologists who were

particularly privileged to have heard this communication, if only because the subject-matter was more familiar to the botanists. As a zoologist himself, he felt it only right to point out that he had to fall back on an Alga, namely *Fucus*, to demonstrate the principle of determination of an axis of polarity by external stimuli. As an Embryologist he considered that some of the most illuminating work which had yet been done in that field was that in which Mr. and Mrs. Snow had determined experimentally some of the conditions controlling the formation and localization of leaf-rudiments, and phyllotaxis. Never, however, had he seen such beautiful material as that which Dr. Knight had described to them that afternoon, with its possibilities for the experimental study of the control of growth, necrosis, sub-equal dichotomy, polarity and gradients.

He hoped that all who had contributed to the discussion would provide accounts of their communications for the Proceedings, not only so that those who had had the pleasure of attending the discussion might refresh their memories, but also in order to give an opportunity to those who were unfortunately prevented from attending, to share in the very valuable and important contributions which had been made.

Professor Dame HELEN GWYNNE-VAUGHAN congratulated the speakers on the great interest of their communications and only regretted that the clear agar from *Gigartina stellata* had not been earlier available.

PROCEEDINGS OF THE GENERAL MEETING ON 17 April 1947

Professor G. R. DE BEER, F.R.S., President, in the Chair.

The Proceedings of the General Meeting held on Thursday, 20 March 1947, having been circulated, were taken as read and confirmed.

The following were thanked for gifts made to the Library since the last meeting:—Dr. W. G. Templeman, the Royal Society of Western Australia and the Pioneer Hi-Bred Corn Co., Des Moines.

In accordance with Chap. 10, Sect. 8 of the Bye-Laws, the following Fellows were elected, by show of hands, as Auditors of the Treasurer's accounts for 1946–47:—

Representing the Council: Mr. A. H. G. ALSTON
Mr. H. W. PARKER

Representing the Fellows: Mr. I. H. BURKILL
Miss E. M. WAKEFIELD.

The following Fellow signed the Obligation in the Roll and Charter Book, and was admitted a Fellow:—Norman Frederick Ellison.

Read for the first time certificates of recommendation of the following candidates,—

Fellowship.—Claude Evrard Aldington Andrews, B.Sc. (Birm.), John Anthony, M.C., M.A., B.Sc., Ilabonto Banerji, D.Sc., Thomas Theodore Barnard, M.C., M.A. (Oxon.), Ph.D. (Cantab.), Peter Robert Bell, B.A. (Cantab.), Bertie Kennedy Blount, M.A., B.Sc. (Oxon.), Dr. Phil. Nat. (Frankf.), Maurice Bradshaw-Bond, Arthur Allman Bullock, B.Sc. (Lond.), Norman Alan Burges, M.Sc. (Syd.), Ph.D. (Cantab.), Charles W. Chew, George Soper Cansdale, B.A.,

B.Sc. (Oxon.), Flt. Lieut. A. J. Cork, D.F.M., Herbert Duerden, B.Sc., Ph.D. (Lond.), Miss Ursula Duncan, Harvey Lawrence Dunkley, Francis Edwards, James Wight Fairbairn, B.Sc., Ph.D. (Lond.), Ph.C., Rex Alan Henry Graham, B.A. (Oxon.), Frank Greenshields, B.Sc., Ph.D. (St. Andr.), John Harrison Halliday, M.A. (Cantab.), Ivor Isaac, B.Sc. (Wales), Ph.D. (Cantab.), William Warwick James, O.B.E., F.R.C.S. (England), L.R.C.P. (Lond.), L.D.S., M.Ch. (Birm.), Gilbert Young Kennedy, B.Sc., Lance Michael John Kramer, M.A. (Cantab.), Ph.D. (Lond.), Miss Joyce Mildred Lambert, B.Sc. (Wales), Professor Sally Lewis, M.A. (Calcutta), Professor Irene Mantôn, B.A., Sc.D. (Cantab.), Ph.D., Leonard Harrison Matthews, Sc.D. (Cantab.), Walter Eric Montgomery, B.Sc., Ph.D. (Lond.), Mark Ogilvie-Grant, B.A. (Oxon.), Miss Mary W. Parke, B.Sc., Ph.D. (L'pool), Herbert William Pugsley, B.A. (Lond.), Gopal Singh Puri, M.Sc., Ph.D., George William Rayner, M.Sc. (Leeds), Rev. H. Santapau, S.J., B.Sc. (Lond.), Ph.D. (Rome), Miss Bernice Giduz Schubert, M.A., B.Sc. Ph.D., Clifford Charles Townsend, E. Ashworth Underwood, M.A., M.D., B.Sc. (Glasg.), Francis Thomas Walker, B.Sc. (Lond.), Miss Kathleen Mabel White, Ph.D. (Reading), John Wilkinson, B.Sc., Ph.D. (Dunelm.).

Foreign Membership.—Professor Auguste Chevalier, Muséum d'Histoire Naturelle, Paris ; Professor Charles Manning Child, The University, Chicago ; Professor Edouard Fischer-Piette, Laboratoire de Malacologie, Paris ; Professor Eric Hultén, Natural History Museum, Stockholm ; Dr. George Gaylord Simpson, American Museum of Natural History, New York.

Associateship honoris causa.—William Gregor Mackenzie, Curator, Chelsea Physic Garden ; Arthur Wilson Stelfox, of the National Museum of Ireland.

The following communications were read and discussed :—

Dr. J. R. Baker. Is the cell-theory true ? (Discussed by the President, Dr. Edward Hindle, Mr. F. C. Grigg, Dr. G. S. Carter ; Dr. Baker replied.)

Abstract.—

Doubt has been thrown on the validity of the cell-theory in several text-books published in recent years. To find whether this doubt is justified, the theory has been re-stated in a series of definite propositions, and the validity of each of these has been investigated separately. The history of the thought summarized in each proposition has also been reviewed.

The President expressed his deep pleasure at the communication from Dr. J. R. Baker and remarked that it was in some way a direct continuation of a discussion which he had had with him 25 years ago. He did not think that anyone who had listened to Dr. Baker could have any objections to raise against his view that for practical and objective purposes the Protozoa and cells of the Metazoa were strictly comparable.

The only reservation which the President felt he was bound to make was of an order which should perhaps be regarded as logical or metaphysical. He was deeply impressed with the demonstrations which experimental researches in zoology and botany had consistently shown, namely, that there was a unity in a multi-cellular organism which transcended its organization into separate cells. The position had been very aptly stated by de Bary when he said that 'the plant makes cells ; cells do not make the plant'. The practical effect of this is that in a multi-cellular organism the cells must be regarded as the products of sub-division of a previously undivided and still integrated whole. He found it impossible to regard a multi-cellular organism as an aggregate of cells.

Dr. P. H. Gregory. The Microbiology of the Air. (Discussed by Mr. H. A. Hyde, Mr. F. Pasquil ; Dr. Gregory replied.)

Abstract.—

(A general review of the factors controlling the vertical and horizontal dispersion of micro-organisms, including pollen, fungus spores and bacteria, leads to conclusions concerning the relative importance of gravity, wind speed and turbulence, and the dimensions of the source. The result of the operation of these factors is seen in the dispersal gradient (the generally observed decrease in numbers of micro-organisms at increasing distances from the source). Methods of measuring such gradients and attempts to fit a curve will be discussed briefly.)

PROCEEDINGS OF THE GENERAL MEETING ON 8 May 1947

Professor G. R. de Beer, F.R.S., President, in the Chair.

The Proceedings of the General Meeting held on Thursday, 17 April 1947, having been circulated, were taken as read and confirmed.

The following were thanked for gifts made to the Library since the last meeting :—Mr. A. H. G. Alston, Mr. J. L. Heller, the Royal Horticultural Society, the University of Queensland, Brisbane, and the Council for Scientific and Industrial Research, East Melbourne, Australia.

Read for the second time certificates of recommendation of the following candidates,—

Fellowship.—Claude Evrard Aldington Andrews, B.Sc. (Birm.), John Anthony, M.C., M.A., B.Sc., Ilabonto Banerji, D.Sc., Thomas Theodore Barnard, M.C., M.A. (Oxon.), Ph.D. (Cantab.), Peter Robert Bell, B.A. (Cantab.), Bertie Kennedy Blount, M.A., B.Sc. (Oxon.), Dr. Phil. Nat. (Frankf.), Maurice Bradshaw-Bond, Arthur Allman Bullock, B.Sc. (Lond.), Norman Alan Burges, M.Sc. (Syd.), Ph.D. (Cantab.), Charles W. Chew, George Soper Cansdale, B.A., B.Sc. (Oxon.), Flt. Lieut. A. J. Cork, D.F.M., Herbert Duerden, B.Sc., Ph.D. (Lond.), Miss Ursula Duncan, Harvey Lawrence Dunkley, Francis Edwards, James Wight Fairbairn, B.Sc., Ph.D. (Lond.), Ph.C., Rex Alan Henry Graham, B.A. (Oxon.), Frank Greenshields, B.Sc., Ph.D. (St. Andr.), John Harrison Halliday, M.A. (Cantab.), Ivor Isaac, B.Sc. (Wales), Ph.D. (Cantab.), William Warwick James, O.B.E., F.R.C.S. (England), L.R.C.P. (Lond.), L.D.S., M.Ch. (Birm.), Gilbert Young Kennedy, B.Sc., Lance Michael John Kramer, M.A. (Cantab.), Ph.D. (Lond.), Miss Joyce Mildred Lambert, B.Sc. (Wales), Professor Sally Lewis, M.A. (Calcutta), Professor Irene Manton, B.A., Sc.D. (Cantab.), Ph.D., Leonard Harrison Matthews, Sc.D. (Cantab.), Walter Eric Montgomery, B.Sc., Ph.D. (Lond.), Mark Ogilvie-Grant, B.A. (Oxon.), Miss Mary W. Parke, B.Sc., Ph.D. (L'pool), Herbert William Pugsley, B.A. (Lond.), Gopal Singh Puri, M.Sc., Ph.D., George William Rayner, M.Sc. (Leeds), Rev. H. Santapau, S.J., B.Sc. (Lond.), Ph.D. (Rome), Miss Bernice Giduz Schubert, M.A., B.Sc., Ph.D., Clifford Charles Townsend, E. Ashworth Underwood, M.A., M.D., B.Sc. (Glasg.), Francis Thomas Walker, B.Sc. (Lond.), Miss Kathleen Mabel White, Ph.D. (Reading), John Wilkinson, B.Sc., Ph.D. (Dunelm.).

Foreign Membership.—Professor Auguste Chevalier, Muséum d'Histoire Naturelle, Paris ; Professor Charles Manning Child, The University, Chicago ; Professor Edouard Fischer-Piette, Laboratoire de Malacologie, Paris ; Professor Eric Hultén, Natural History Museum, Stockholm ; Dr. George Gaylord Simpson, American Museum of Natural History, New York.

Associateship honoris causa.—William Gregor Mackenzie, Curator, Chelsea Physic Garden ; Arthur Wilson Stelfox, of the National Museum of Ireland.

The President welcomed the presence at the Meeting of Dr. George Gaylord Simpson, of the American Museum of Natural History, New York.

The President reported the deaths of Ralph Ellis, Cecil Norman and Arthur Smith, Fellows of the Society.

The following communications were read and discussed :—

Professor G. R. de Beer, F.R.S., Pres.L.S. Edmund Davall, F.L.S., an unwritten English chapter in the history of Swiss Botany. (Discussed by Mr. A. J. Wilmott ; the President replied.) [Printed in full, in Proc. **159**, pt. 1.]

Miss Muriel Whiting. An abnormal Forget-me-not from Trimley, near Ipswich. (Exhibit.)

Dr. R. Melville. The Coritanian Elm. (Discussed by Mr. A. J. Wilmott ; Dr. Melville replied.) [To be printed in the Journal, Botany.]

Dr. C. F. A. Pantin, F.R.S. A new British land Planarian and a land Nemertine. (Discussed by the President, Dr. H. A. Baylis, Dr. S. M. Manton, Miss R. F. Shove, Dr. E. Hindle and Dr. J. Ramsbottom ; Dr. Pantin replied.)

Abstract.—

In recent years a terrestrial nemertine has been found in large numbers at various sites in the West of England and Wales from Cheshire to Devon. The occurrence of this nemertine presents many interesting problems. Although a terrestrial animal, it is extremely sensitive to lack of water in all stages of its life history. Nevertheless, it has become widely distributed. This worm is apparently not indigenous, but an immigrant from Australia. A species of terrestrial planarian new to Britain has also been found at a number of sites. Structurally, it appears to be closely related to *Rhynchodemus sylvaticus* of North America and to *R. bilineatus*, a rare flat-worm from the continent of Europe. The worm belongs to a different sub-family from that of the known British land planarians. It presents many structural features of interest. Conditions governing the discovery of small cryptozoic animals such as these were briefly discussed.

The following papers were read in title :—

'Further notes on the structure of Lyomeri'. By Dr. V. Tchernavin. [Printed in the Journal, Zoology, **51** (no. 280).]

'On the origin and meaning of South American Indian Potato names'. By J. G. Hawkes, M.A., Ph.D. [Printed in the Journal, Botany **53** (no. 350).]

'The Breeding Cycle of an Equatorial Bat (*Pteropus giganteus*) of Ceylon'. By A. J. Marshall, B.Sc. (Communicated by Professor A. C. Hardy, F.R.S.) [Printed in full, below.]

' Description of a new genus of Crab from Macclesfield Bank (Parthenopidae, Eumedoninae) '. By ISABELLA GORDON, D.Sc., Ph.D. [Printed in full, below.]

' Some Roundworms and Flatworms from the West Indies and Surinam.—I. Nematodes and Acanthocephala '; II. Cestodes. By H. A. BAYLIS, M.A., D.Sc. [Printed in the Journal, Zoology, **51** (no. 280).]

' A Prodromus of the British *Hieracia* '. By H. W. PUGSLEY, B.A. [To be printed as a volume of the Journal, Botany.]

' Synopses of the British Fauna.—No. 6. Lumbricidae (Annelida) with a key to the common species '. By L. CERNOSVITOV † and A. C. EVANS.

' On the Occurrence of a member of the Tremandraceae in Ceylon '. By Professor B. FEDTSCHENKO, F.M.L.S. [Printed in full, below.]

The President announced that His Excellency The French Ambassador would be present at the Anniversary Meeting to be held on Saturday, 24 May at 11.0 A.M.

THE BREEDING CYCLE OF AN EQUATORIAL BAT (PTEROPUS GIGANTEUS OF CEYLON)

By A. J. MARSHALL, B.Sc., Beit Memorial Research Fellow.

(From the Department of Zoology and Comparative Anatomy, Oxford.)
(Communicated by Professor A. C. Hardy, F.R.S.)

(With 2 text-figures.)

Introduction.

The breeding seasons of vertebrates in a tropical rain-forest were investigated by the Oxford University Expedition to the New Hebrides (1933–34), and our results have been summarized by the leader, Dr. John R. Baker (1). They show that in one of the most equable climates in the world the terrestrial vertebrates generally retain as sharply defined breeding seasons as those living in countries where the seasons are clearly marked.

A fruit-bat, *Pteropus geddiei*, was among the animals studied in detail. In a brief survey (2) of the recorded breeding of the Pteropidae in general, it has been pointed out that there is a general tendency for the family to produce young about March–April, north of latitude 4° N. and about September from latitude 3° N.; *i.e.*, a kind of ' biological equator ' for fruit-bats appears to exist slightly north of the equator. The gestation period of the biggest fruit-bats appears to be about five or six months, so that whatever the latitude and climate of their habitat, the Pteropidae tend (like sheep and deer) to copulate in the autumn and bear their young in the spring. They even carry these seasonal tendencies into the equatorial belt, where there are no seasons that correspond in any obvious way to ' spring ' or ' autumn '.

It was thought important, therefore, to undertake a detailed investigation of a single-season animal as close to the actual equator as possible. I am indebted to Dr. J. R. Baker for his generous gift of the present *Pt. giganteus* material from Ceylon, and for valuable suggestions during its investigation; and to Mr. E. C. Fernando of the Colombo Museum, who collected it originally on Dr. Baker's behalf. I acknowledge also my debt to The Carnegie Committee or a research grant, and to Miss Jean Morpeth for assistance in the laboratory.

General remarks on Pt. giganteus.

The vegetarian *Pt. giganteus* Brünnich or 'flying fox' of India, Burma and Ceylon is a large bright golden or reddish brown bat, probably the largest known, attaining in the male a wing-span of 50 inches and a body-weight of 2¼ lbs. The females weigh about half a pound less (3). The species is common in the lowland rain-forests of Ceylon, where it lives in large colonies at favourite sites, from which it disperses each nightfall to feed on the flowers and honey of the silk-cotton, introduced *Eucalyptus*, *Albizzia*, dadap, rubber-tree, coconut-palm, and the fruit-pulp of mango, jak, soursop, guava and many indigenous rain-forest trees as they successively flower and fruit at different times and localities. The species is not plentiful at altitudes higher than 3,000 feet, but may fly as far as 30 miles and back for the nocturnal meal *. The diet varies from month to month.

The specimens dealt with in the present paper were all taken at sea-level in the Colombo area (7° N.) in every month of the year except June and July during the years 1936–38. The collection of ten mature individuals of each sex between the 10th and 20th of each month was aimed at; but although this was not possible in some months, some 116 adult males and 95 adult females have been examined. As soon as possible after shooting, the reproductive organs were dissected out by the collector and preserved in Bouin's fluid, with date, forearm length and locality details attached to each set of organs. The material has retained its histological characters well; it is clear that Bouin's fluid is very suitable for prolonged preservation.

An attempt was made to establish forearm criteria for maturity in *Pt. giganteus* but owing to a paucity of non-adults this was impossible. All testes examined came from animals with forearms of 170 mm. or longer. A random sample of 25 males showed a mean forearm length of 180·6 mm., varying between 170 and 195 mm. Sperms were present in the epididymides of the specimens from bats with the shortest forearms. A group of 25 pregnant females averaged 180·1 in the forearm, the length of which ranged from 173 to 195 mm. Of 27 uteri obtained during February, March, April and May (when pregnancy is unmistakable at a glance), all contained embryos, except one which was obtained from a bat with a forearm measurement of 160 mm. It would appear, therefore, that one criterion for sexual maturity in the female is a forearm approaching 170 mm.

Phillip's (3) figures for *Pt. giganteus* indicate that the female body-weight is approximately two-sevenths less than that of the male, and in the New Hebrides our heaviest female weighed only 875 grams as against 1084 gm. of the heaviest male. In the light of these figures, the above relative forearm lengths are interesting. The fact that the female has a forearm as long as that of the male may be related to the weight of the young one that she has to carry in flight. Females weigh up to 794 gms. (Phillips). The heaviest embryo in the collection examined by me weighed (with placenta) no less than 118 gms. (preserved in Bouin's fluid). For about three months after parturition the rapidly growing young one is carried over long distances, clinging to the fur of the ventral surface of the mother.

The Climate and the breeding cycle.

The range of temperature and humidity in the central western lowlands of Ceylon is small (Table I); the climate of Colombo is noted for its stability (4). The briefest glance at the *Pteropus* material, however, revealed a sharply defined single breeding season. All observed conceptions occurred in the few weeks between early December and early January, and parturition took place in late May and perhaps early June. The gestation period is thus of about six months, and the number of young was invariably one.

* Personal communication from Mr. E. C. Fernando.

TABLE I.—The Colombo Climate.

	XII.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.
Mean rainfall in inches	5·7	4·0	2·2	4·8	8·8	15·0	9·0	6·0	2·7	7·0	14·2	12·3
Mean Temperature (° F.), dry bulb ...	78·8	79·1	79·2	80·7	81·6	81·8	81·2	80·9	80·5	80·9	79·7	79·1
Mean Temperature (° F.), wet bulb ...	73·8	73·4	73·6	75·6	77·2	77·7	77·0	76·4	76·2	76·2	75·8	75·1
Mean air pressures (in decimals of an inch of Hg.)	0·905	0·922	0·919	0·895	0·857	0·833	0·827	0·840	0·861	0·872	0·889	0·785

TABLE II.—Occurrence of pregnant females arranged according to weight of embryo and uterus.

Weight of embryo (including placenta) in grams.	1936–37 Dec.	Jan.	Feb.	March	April	May	1937–38 Dec.	Jan.	Feb.	March	April	May
80 and over						•••						
40–79					•••							
20–39				•••	•							
10–19				•								
6–9			••• •••									
4–5·9			••• ••									
2–3·9	••• ••• •••		••• •				•••	••• ••				
1–1·9	••• ••						•••• ••• ••• ••• ••• •••	••• ••• ••• •••				

No female bats were collected during June–August. In the period September–November, 16 mature (lowest forearm-length 173 mm.) females were taken, but none of these were pregnant. Every specimen examined from December and January was pregnant.

Table II shows the breeding season of *Pt. giganteus* and the occurrence of pregnant females, arranged according to weight of uterus and embryo. (The weight of the uterus is relatively insignificant except in the early stages of pregnancy, and may be neglected.) The weights given are those of the preserved specimen and are about one-tenth less than when fresh.

Impregnation occurs near the distal end of the left or right horn in approximately equal numbers. A virgin horn varies from 2 mm. to 2·5 mm. in diameter. The mean diameters of pregnant uterine horns are summarized in Table III.

TABLE III.

December	January	February	March	April	May
3 mm. (22)*	5·7 mm. (17)	23 mm. (5)	44 mm. (4)	57 mm. (4)	75 mm. (3)

(* The figure in brackets refers to total number of pregnant specimens referred to in this table. The specimens of the first four months all came from the same locality at Dehiwala.)

A large series (22) of females taken in December 1937, at Dehiwala, nearly all had one uterine horn or other slightly, yet appreciably swollen to the naked eye. The mean weight of the uteri of this group was 1·2 gm. and identical with that of the previous (pre-fertilization) month. Although most of this December material appeared obviously pregnant, and serial sectioning revealed considerable modification of the epithelial glands of the swollen horn, no embryo was found in the first three uteri examined. Further investigation revealed that pronounced uterine modification takes place, while the fertilized ovum, in the 4- to 16-celled morula stage, is still descending the fallopian tube. This phenomenon is discussed in a later paper.

Specimens taken one year and four days earlier (in December 1936) at Gampaha, a bat colony 20 miles away, had the pregnant horn rather more swollen (diameter 5·3 mm. and wt. 2·2 gm.) than the foregoing. In these, implantation had taken place. The uteri showing the largest swelling contained an embryo still in the primitive plate stage. There was as yet no sign of a neural groove. The amniotic cavity had formed, but the amnion was not yet complete, as the mesoderm had not yet grown completely around it. The large yolk-sac was bounded below by the trophoblast and endoderm only; the mesoderm had only spread around its upper side. The diameter of the whole blastocyst was about 2·5 mm. Kohlbrugge's (6) 'Figure 0' (on unnumbered plate) shows a fruit-bat embryo at almost exactly the same stage of development as that described above.

The January material from Dehiwala in 1938 proved that conception date varies somewhat within an individual bat colony. Here the diameter of the pregnant horn (17 examples) ranged from a barely perceptible bulge to two horns with a diameter of 8 mm. Taken in conjunction with those of the previous month, these uteri suggest that conception is spread over about four weeks.

Examination of the male cycle of *Pt. giganteus* reveals a striking physiological similarity with that of *Pt. geddiei* (fig. 1). In both animals the weight of the testes becomes sharply reduced during and after the first month of conception. It is interesting that the weight of the testes of *Pt. giganteus* is more than double that of *Pt. geddiei*, a bat of almost exactly the same size. Both species exhibit the same darkening effect as the testes contract during the 'off' season. The epididymides of adult *Pt. giganteus* contain sperms all

the year round but, unlike *Pt. geddiei*, in varying quantities. Sperm abundance in *Pt. giganteus* corresponds closely with testis weight: in August and September sperms are numerous, in October more so, whilst in November and December the lumen of the tubules are densely packed with them. Although

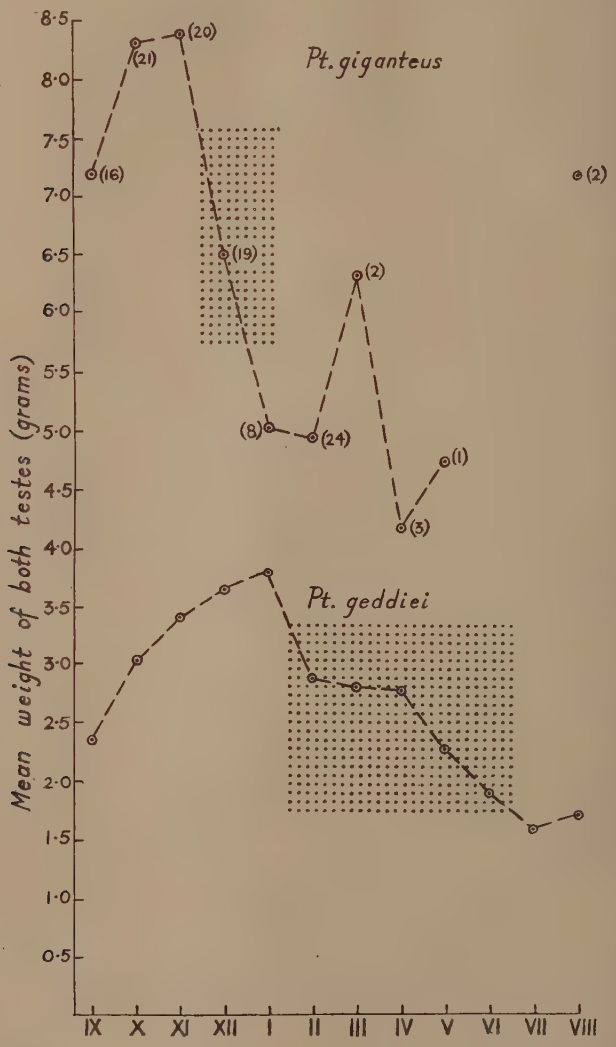


FIG. 1.—Showing male cycle (expressed as mean weight of both testes in grams) in *Pteropus giganteus* and *Pt. geddiei*. Shaded area indicates copulation seasons.

the lumen remain large there appears to be a reduction in sperm numbers in January and February, and a considerable falling off in numbers in April and May. In all months, however, sperms are plentiful. Some individuals shot during the months approaching parturition were still loaded with them.

In all months in which specimens were collected (*i. e.*, all except June and July), spermatocytes and spermatids were found among the sperms in the epididymides. Their numbers varied from a few to a great many. At various levels of the epithelium of the epididymis were noticed nuclei apparently in the process of migration towards the lumen. This was a constant feature, and since

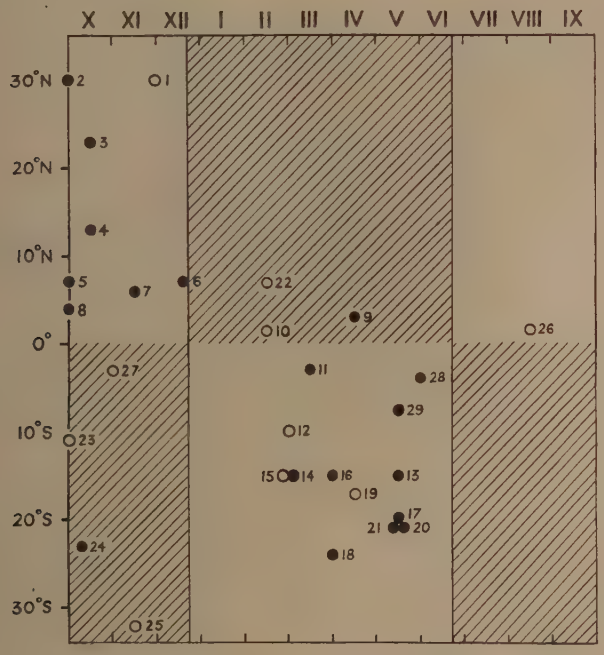


FIG. 2.—Diagram showing seasonal changes in length of daylight in relation to copulating dates in the Pteropidae. Shaded sections indicate period of increasing light. Black symbols (●) represent species whose data is considered reliable. White symbols (○) represent species in which there is some doubt concerning exact month of copulation. Where copulation is known to spread over several months, the mid-period is given. Where a species ranges over several degrees of latitude, the middle of the range is given. Numbers 1–25 refer to species in vertical order in Appendix 1 in Baker and Baker (2). In the case of No. 6 (*Pt. giganteus*) the data presented in this paper are used. Species 26–29 are as follows: 26, *Ptergystes stenopterus* from Nias Is., for which, see Kohlbrugge (5); 27, *Cynopterus marginatus* from "Dutch East Indies", Keibel (6); 28, *Pteropus edulis* from Sunda Is., etc., Selenka (7); and 28, *Xantharpya amplexicaudata* from Java, Kohlbrugge (5).

About 250 females of *Chaerophon plicatus* were collected at Bandung (Java) in January–February, but not one was pregnant (Kohlbrugge). This would fit in well with the breeding seasons of other Pteropidae if these females were about to become pregnant in the succeeding months.

they were never observed actually in the lumen it is presumed that they disintegrated on reaching the free border of the cells. No seasonal variation was detected in either of the above phenomena.

Discussion.

A sharply defined breeding season has been shown for *Pt. giganteus* despite the climatic stability of its habitat, in which the range of temperature, humidity

and pressure is very small. At a latitude of 7° the concepts of season as understood by Europeans are meaningless. There is, of course, a small seasonal change in length of day. The food chosen by *Pt. giganteus* varies throughout the year, and the animal is extremely active throughout the year in quest of it. The peculiar feeding habits of the Pteropidae—they appear to spit out seeds and fibrous material and to ingest only pulp and mostly unidentifiable juices—makes it difficult to determine exact diet variations.

A large random sample of specimens taken over three years indicates that *Pt. giganteus* conceives from early December until early January. The first conceptions take place a week or two before light begins to increase in intensity. At the same time there is a tendency towards a slight rise in rainfall, a drop in temperature, a rise in humidity and in barometric pressure. No ultra-violet light recordings are available.

During the period when testis-weight and sperm numbers are increasing, the length of day is decreasing. Both sexes of bats, hanging in their ' camps ' in the jungle top, are exposed to dappled sunlight throughout the year.

Although the epididymides of *Pt. giganteus* contain an abundance of sperms throughout the year, there is a sharp increase in numbers in the two months immediately preceding the December conception. Births occur late in May or very early in June. Unfortunately there are no data which indicate with any certainty the lactation period of any of the genus. We have no idea at what period oestrus recurs after parturition. The material under discussion came from four individual bat colonies. That the developmental rhythms of these colonies are not more widely divergent seems to indicate that some indeterminable, overall climatic or habitational influence is at work which controls the periodicity of the whole scattered population.

Information available concerning the breeding seasons of Ceylonese vertebrates is fragmentary and generally unsatisfactory ; but, such as it is, it indicates that in every month some mammal or other is breeding. Among bats pregnancy is found at all times of the year (Phillips), but with no distinct tendency at any particular period. Clearly the environmental factors which stimulate, and ' anchor ', the physiological rhythm in each species are various, and highly specific to the individual species.

The breeding cycle of *Pt. giganteus* reinforces Baker's generalization that the Pteropidae, tropical or otherwise, tend to copulate in ' autumn ' and bear their young in ' spring '. Fig. II shows this diagrammatically in so far as the published references will admit. The diagram shows the strong tendency for the copulating season of the Pteropidae to lie in the middle and end of the period during which the days are shortening ; that is to say, in the ' autumn ', though this word loses its ordinary significance in the tropics. The evidence suggests that the copulating season sweeps across the equatorial region in the early months of the year. More data are required.

The only reliable exception to these generalizations is provided by *Pt. scapulatus*, which copulates (in Australia) while the days are lengthening.

Summary.

(1) The fruit-bat *Pteropus giganteus*, living in the equable tropical climate of Western Ceylon (7° N.), has a sharply defined annual breeding season.

(2) The testes increase in weight while the days are growing shorter. They are heaviest in October–November. Their weight decreases sharply about the time the eggs are fertilized and shortly afterwards. Sperms are abundant in the epididymides throughout the year.

(3) Conception occurs in December, shortly before the length of day begins to increase. Pregnancy lasts about six months, so that the young are born in May.

(4) An analysis of all available data shows that the Pteropidae tend to copulate while the days are growing shorter.

References.

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DESCRIPTION OF A NEW SPECIES OF CRAB FROM MACCLESFIELD BANK (PARTHENOPIDAE, EUMEDONINAE)

By Isabella Gordon, D.Sc., Ph.D.

Included in an assorted lot of unnamed Decapoda in the British Museum (Nat. Hist.) Collection, is a Parthenopid crab that proves to belong to an undescribed species of the genus *Harrovia*. In 1943 I prepared the following description and figures; but, having had no occasion to return to a study of the Parthenopidae, I think it advisable to publish the description separately now.

Harrovia egeriae, sp. n.

Material.—Holotype, an ovigerous ♀ measuring 11×16·6 mm. from Macclesfield Bank, 45 fms., H.M.S. Egeria, coll. Bassett Smith. Reg. no. 93.11.3.79.

Description.—The carapace is hexagonal but, owing to the presence of an unusually massive lateral spinose projection, is much wider than is characteristic of the genus *Harrovia*. The areolation of the carapace and the distribution of the small granules, represented in fig. 1 *a*, are distinctly seen when the specimen has been allowed to dry. The widest part, comprising the lateral projections and the gastric region with its prominent proto- and flatter meso-gastric lobes, is also the highest. From this median area the carapace slopes away anteriorly, laterally and posteriorly. The deflexed front is distinctly concave between the raised convex lateral lobes. The anterolateral border is subdivided into four lobes, the third being much larger than the fourth and forming the greater part of the stout lateral spine.

In ventral aspect the median frontal lobes are not separated from the small lateral ones except anteriorly, the depression that I referred to as the 'antennal groove' being absent (fig. 1 *b*) *. The eye-stalk is comparatively slender.

The chelipeds are short, massive and closely studded with bead-like granules. The right, the larger of the two, is approximately equal to the width of the carapace. The merus is short and stout and is not visible beyond the antero-lateral margin; there is a prominent tooth-like lobule near the distal end of the upper edge. A similar lobe is present on the carpus (fig. 1 *a*). The chela is represented in fig. 1 *c*; the granules cover the entire outer, most of the inner, surface and spread on to the short, stout fingers.

* *Cf.* Gordon, 1934, *Mém. Mus. Royal Hist. Nat. Belgique*, Hors Série III, fasc. 15, p. 64, fig. 33 *c* and *d*.

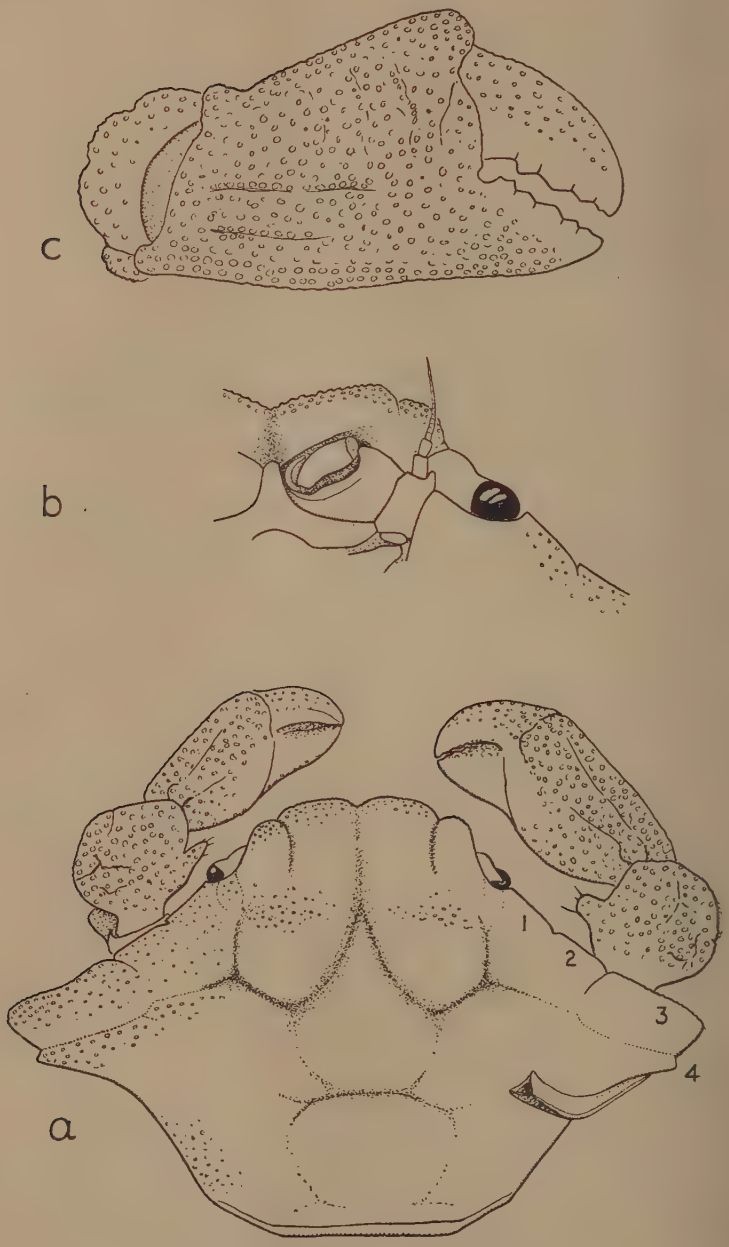

FIG. 1.—*Harrovia egeriae*, sp. n. Holotype.
a. Carapace and chelipeds, in dorsal aspect, × *circa* 8.
b. Frontal region of carapace, in ventral aspect, further enlarged.
c. Right chela, further enlarged.

The walking legs are much more slender than the chelipeds and the first, which is appreciably longer than the fourth, extends to the base of the immobile finger of the left cheliped.

The difference between the dactylus of the first and subsequent pairs is not so pronounced as in *H. purpurea* Gordon (1934, p. 66, fig. 34 *b*, *c*.)

The abdomen is much narrower than in some females belonging to the Eumedoninae, the maximum width being equal to the sum of the first five segments.

Remarks.—The shape of the carapace distinguishes this from all the known species of the genus *Harrovia*. Usually the width of the carapace does not greatly exceed the length. According to Sakai, however, the width is at least half as much again as the length * in both *H. elegans* de Man and *H. trilobata* Sakai (1938, 'Studies on the Crabs of Japan III. *Brachygnatha Oxyrhyncha*, Tokyo, p. 350, pl. 33, fig. 1 and p. 352, text-fig. 55.) In most, if not in all, species of *Harrovia* the anterolateral margin is subdivided into four lobes, the last one or two of which may be spinose. It is easy to imagine that two spines, such as occur in *H. elegans*, might fuse to form one large spinose projection as in *H. egeriae*.

In most species of *Harrovia* and *Ceratocarcinus* the chelipeds are relatively long, the merus projecting well beyond the margin of the carapace. Short chelipeds, however, occur in *H. truncata* Rathbun (1906, Bull. U.S. Fish Comm. for 1903, pt. III, p. 886, p. xiv, fig. 8), in *Ceratocarcinus spinosus* Miers (1879, Ann. Mag. Nat. Hist. (5), iv, p. 27, pl. v, fig. 11) and is usual in the genus *Eumedonus*.

As regards the shape of the front or rostrum, this species is most closely allied to *H. purpurea* Gordon (1934, p. 68, fig. 35). In that species, however, the chelipeds are longer and more slender; the fourth lobe of the anterolateral margin alone forms the lateral spine; the eyes are larger; there is also a very distinctive colour pattern beneath the short tomentum that covers the entire dorsal surface of the carapace. The holotype of *H. egeriae* has been in spirit for nearly 50 years and no trace of any colour pattern remains. If there is any tomentum on the carapace it has been entirely rubbed off.

The abdomen, as mentioned above, is narrow; in fact it is narrower than that of the ♀ syntype of *H. albolineata* Ad. and Wh., although the latter is a much smaller specimen (carapace 7·4×9·5 mm.). In a ♀ syntype of *Proechinoecus sculptus* Ward the width of the abdomen actually exceeds the length of the carapace; in *H. egeriae* it is less than half the carapace length.

ON THE OCCURRENCE OF A MEMBER OF THE TREMANDRACEAE IN CEYLON

By B. Fedtschenko, F.M.L.S.

Few families of plants are so restricted in their distribution as to occur only in very limited areas which do not transgress the boundaries either of a small and well-defined geographical region or of a natural floristic region. To such families belong the Tremandraceae, with three genera, two each including two or three species, and a third, *Tetratheca*, which includes about twenty species. Hitherto, the members of the Tremandraceae have been regarded as very strictly limited to Australia, some occurring in the east and in Tasmania, others in the west of that continent. Systematists place the Tremandraceae close to the Polygalaceae, within the Geraniales.

While I was arranging in the V. L. Komarov Herbarium of the Botanical Institute of the Academy of Sciences of the U.S.S.R., the collection of plants made in Ceylon in 1908, by V. L. Lipsky, Chief Botanist of the St. Petersburg

* Excluding the outer spinose frontal lobe, which is in advance of the median lobe.

Botanical Gardens, and his assistant, A. I. Michelson, I found three sheets of a plant, gathered near Nuragelia (Nuwara-Eliya), Ceylon, which could not be determined by reference to Trimen's *Flora of Ceylon*. Reference to other sources eventually showed, to my surprise, that the sheets bore specimens of a member of the Tremandraceae. It was easy to determine the genus as *Tetratheca*, but as there are some twenty Australian species of that genus closely related and often separated only by critical characters, the naming of the species was not easy. Finally it became clear that the plant was *Tetratheca pubescens* Turcz., described by Turczaninov from West Australia and unknown elsewhere. Consequently the occurrence of *Tetratheca pubescens* Turcz. in Ceylon, as a member of the flora of Asia, is a fact quite new to botanical science.

It seems impossible that so conspicuous a plant as *Tetratheca pubescens*, growing in so well-frequented a spot as Nuwara-Eliya, could have been overlooked by previous botanical explorers of Ceylon, and this suggests that the plant was adventive there. It doubtless found its way into Ceylon between 1900, when Trimen's *Flora of Ceylon* was published, and 1908, when the island was visited by Lipsky.

PROCEEDINGS OF THE ANNIVERSARY MEETING
24 May 1947

Professor G. R. de Beer, F.R.S., President.
in the Chair.

The Proceedings of the General Meeting held on Thursday, 8 May 1947, having been circulated, were taken as read and confirmed.

The following were thanked for gifts made to the Library since the last meeting :—Professor Maurice Caullery, Mr. P. Helveg Jespersen and the Field Naturalists' Section of the Royal Society of South Australia, Adelaide.

The following Fellows signed the Obligation in the Roll and Charter Book, and were admitted Fellows :— Mr. Earle Leslie Davison, Mr. Douglas Dawson, and Mr. William Marshall.

Candidates for membership were balloted for and elected :—

Fellowship.—Claude Evrard Aldington Andrews, B.Sc. (Birm.), John Anthony, M.C., M.A., B.Sc., Ilabonto Banerji, D.Sc., Thomas Theodore Barnard, M.C., M.A. (Oxon.), Ph.D. (Cantab.), Peter Robert Bell, B.A. (Cantab.), Bertie Kennedy Blount, M.A., B.Sc. (Oxon.), Dr. Phil. Nat. (Frankf.), Maurice Bradshaw-Bond, Arthur Allman Bullock, B.Sc. (Lond.), Norman Alan Burges, M.Sc. (Syd.), Ph.D. (Cantab.), Charles W. Chew, George Soper Cansdale, B.A., B.Sc. (Oxon.), Flt. Lieut. A. J. Cork, D.F.M., Herbert Duerden, B.Sc., Ph.D. (Lond.), Miss Ursula Duncan, Harvey Lawrence Dunkley, Francis Edwards, James Wight Fairbairn, B.Sc., Ph.D. (Lond.), Ph.C., Rex Alan Henry Graham, B.A. (Oxon.), Frank Greenshields, B.Sc., Ph.D. (St. Andr.), John Harrison Halliday, M.A. (Cantab.), Ivor Isaac, B.Sc. (Wales), Ph.D. (Cantab.), William Warwick James, O.B.E., F.R.C.S. (England), L.R.C.P. (Lond.), L.D.S., M.Ch. (Birm.), Gilbert Young Kennedy, B.Sc., Lance Michael John Kramer, M.A. (Cantab.), Ph.D. (Lond.), Miss Joyce Mildred Lambert, B.Sc. (Wales), Professor Sally Lewis, M.A. (Calcutta), Professor Irene Manton, B.A., Sc.D. (Cantab.), Ph.D., Leonard Harrison Matthews, Sc.D. (Cantab.), Walter Eric Montgomery, B.Sc., Ph.D. (Lond.), Mark Ogilvie-Grant, B.A.

(Oxon.), Miss Mary W. Parke, B.Sc., Ph.D. (L'pool), Herbert William Pugsley, B.A. (Lond.), Gopal Singh Puri, M.Sc., Ph.D., George William Rayner, M.Sc. (Leeds), Rev. H. Santapau, S.J., B.Sc. (Lond.), Ph.D. (Rome), Miss Bernice Giduz Schubert, M.A., B.Sc., Ph.D., Clifford Charles Townsend, E. Ashworth Underwood, M.A., M.D., B.Sc. (Glasg.), Francis Thomas Walker, B.Sc. (Lond.), Miss Kathleen Mabel White, Ph.D. (Reading), John Wilkinson, B.Sc., Ph.D. (Dunelm.).

Foreign Membership.—Professor Auguste Chevalier, Muséum d'Histoire Naturelle, Paris ; Professor Charles Manning Child, The University, Chicago ; Professor Edouard Fischer-Piette, Laboratoire de Malacologie, Paris ; Professor Erik Hultén, Natural History Museum, Stockholm ; Dr. George Gaylord Simpson, American Museum of Natural History, New York.

Associateship honoris causa —William Gregor Mackenzie, Curator, Chelsea Physic Garden ; Arthur Wilson Stelfox, of the National Museum of Ireland.

The Bye-Laws regulating the Election of Council and Officers having been read by the Assistant Secretary, the PRESIDENT declared the Ballot for New Members of Council to be open, and voting began. The PRESIDENT thereafter appointed Mr. W. S. Rowntree, Mr. I. H. Burkill and Dr. J. Hutchinson as Scrutineers of the Ballot.

The Ballot was closed at the due time, and the result declared to the Meeting,—NEW MEMBERS OF COUNCIL.—Prof. G. D. Hale Carpenter, M.B.E., Mrs. Vera Higgins, M.A., V.M.H., Mr. E. W. Mason, M.A., M.Sc., Dr. W. E. Swinton, Dr. George Taylor.

(The retiring Councillors were Dr. Margaret A. Brett, Mr. A. D. Cotton, O.B.E., Dr. R. Dennell, Miss R. F. Shove, and Mr. R. Winckworth.)

The PRESIDENT declared the Ballot for Officers to be open and voting began. The Ballot was closed at the due time, and the result declared to the Meeting,—OFFICERS.—*President* : Professor G. R. DE BEER, F.R.S. ; *Treasurer* : Colonel F. C. Stern, O.B.E., M.C. ; *Botanical Secretary* : Dr. B. Barnes ; *Zoological Secretary* : Dr. Malcolm A. Smith.

In handing the Linnean Gold Medal to Professor MAURICE CAULLERY, F.M.L.S., the PRESIDENT addressed him as follows :—

Professor CAULLERY :

In awarding to you the Linnean Gold Medal, the highest honour within its power, the Linnean Society of London is not only proud to add your name to those of Richard Owen, T. H. Huxley, A. R. Wallace, E. Haeckel, R. A. von Kölliker, G. O. Sars, Ray Lankester, and E. S. Goodrich, who have added to its lustre in the past ; but it has in addition wished to express its appreciation of the services which you have given to biological science, and through you to pay tribute to the scientific genius of the French Nation.

It is now fifty years since you communicated the results of your investigations into the epitokous forms and the evolution of the Cirratulidæ. This was followed by your researches into the Orthonectidae, on *Hemioniscus*, and on *Fecampia*. Turning your attention to the Protozoa, you worked on the Actinomyxidae, and laid the foundations of our knowledge of a new group altogether, the Haplosporidia. You studied the stages of development of the Epicaridea and extended greatly our knowledge of the biology of parasitism

by your researches on *Labidognathus*, *Monstrilla*, *Ancyroniscus*, and on *Xenocoeloma*, in which you demonstrated the astonishing fact that this parasitic Copepod was enclosed within an epiderma provided by its Annelid host *Polycirrus*.

In addition to your researches, you have never neglected the syntheses of knowledge which are so necessary in order to take stock of the state of scientific progress in the various fields. In particular we recall your works on Problems of Sexuality, Universities and the Scientific Movement in the United States, Parasitism and Symbiosis, the History of French Biology, Genetics and Heredity, the Biology of Twins. Your work on Problems of Evolution is particularly cherished by this Society, for it was before us that Darwin and Wallace made the first public communication of the theory of Evolution by means of Natural Selection, in 1858. It is therefore very appropriate that you should have occupied the position of Director of the Laboratory of Organic Evolution at the Mother of all our Universities, the Sorbonne.

Your position in the scientific World of France, and indeed of the world, is one of pre-eminence. During your long and active career your students have included many of the holders of Chairs of Zoology in France and in other countries. The congratulatory Volume presented to you on the occasion of your Scientific Jubilee is eloquent testimony of the tribute paid to you.

We are not unmindful of the fact that your eminence in the cultural life of France, marked as it is by your membership of the Academy of Sciences, secured for you the additional honour of arrest by the occupying power during the late war, and we rejoice that the results of that episode were no more serious than they were.

In presenting you with the Linnean Medal, we are attempting to discharge some of the debt which British biologists owe to you, and we are forging a new link to add to the chain of connexions between our Society and your illustrious countrymen. We have had the honour of including among our Foreign Members the names of Antoine Laurent and Adrien de Jussieu, Antoine Gouan, Jean Baptiste Lamarck, Pierre André La Treille, Henri Ducrotey de Blainville, Georges Cuvier, Henri Milne Edwards, Henri de Lacaze Duthiers, Yves Delage, and Alfred Giard, in addition to your own which we are now privileged to include among those of our Linnean Medallists.

Professor CAULLERY, in accepting the Medal, said he felt a great admiration for the beautiful continuity of Britain's great institutions, one of which was the Linnean Society. He presented to the Society's Library one of his recent memoirs.

The Librarian and Assistant Secretary presented his Report.

LIBRARIAN AND ASSISTANT SECRETARY'S REPORT

List of the Society.—Since the last Anniversary Meeting the Society has lost 31 members. The detailed statement is as follows,—

11 *Fellows by death*,—F. H. Baker, B. H. Bentley, Lady Richmond Brown, Ralph Ellis, A. W. J. Haggis, T. L. Lancaster, W. H. Mullens, Cecil Norman, Arthur Smith, Charles Taborn, Rev. Alfred Thornley.

5 *Foreign Members by death*,—L. Diels, H. Driesch, R. A. Harper, L. Jost, K. H. Stephensen.

2 *Associates honoris causa*,—A. Bruce Jackson, R. Newstead.

12 *Fellows by Withdrawal*,—J. P. T. Burchell, M.C., C. C. Dowding, F. M. Haines, T. H. Hawkins, F. Y. Henderson, T. K. Koshy, Mary R. Lambert, R. T. Millott, Guy Peirson, N. Parthasarathy, R. H. Pott, Gordon Wright.

1 *Fellow by Removal from the List*,—H. G. Schweickerdt.

The number of Fellows on the List is 627 with 41 elected to-day and not yet qualified. 5 Foreign Members, 2 Associates *honoris causa* and 6 ordinary Associates have been elected.

Library.—Between the 1 May, 1946 and 30 April, 1947, 18 Books have been purchased; 18 Books and 128 Parts of Periodical publications and 96 Reprints have been presented. During the same period the number of volumes bound was 178.

The number of volumes borrowed by Fellows and Associates was 1,009, and by the National Central Library 287. 576 signatures were recorded in the Library Visitors' Book.

The Linnaean Collections have now been back in the Society's Rooms a year, and have been subjected to a careful preliminary examination.

The Financial Report was given by the Treasurer and the Accounts of the Society, duly audited, for the year 1946–47 were laid before the meeting.

On a motion by Dr. S. E. Chandler, O.B.E., seconded by Miss R. F. Shove, the Report and Statement of Accounts were adopted.

Treasurer's Accounts for the

(Presented at the Anniversary

Receipts and Payments of the Linnean Society

General

Receipts	£	s.	d.	£	s.	d.
To Balance at 1 May 1946 :—						
Current Account at Bank	479	6	11			
Deposit Account Post Office Savings Bank	2041	18	7			
Cash in hand	17	19	2			
				2539	4	8
„ Admission Fees				88	0	0
„ Arrears of Annual Contributions	134	6	11			
„ Annual Contributions for year	2085	9	8			
Do. in advance	46	7	0			
				2266	3	7
„ Do. of Associates				13	0	0
„ Composition Fees				197	0	0
„ Interest on Investments (including Income Tax recovered)				325	16	4
Do. Post Office Savings Bank Account				124	3	0
„ Sales of Publications :—						
Transactions	12	4	9			
Journals	66	15	7			
Proceedings &c.	55	7	3			
				134	7	7
„ Grants and donations in aid of Publications				800	0	0
„ Miscellaneous Receipts				23	15	9
„ Sale of Packing Cases (Linnaean Collections)				21	12	0
„ Receipts from Advertisements (including arrears)				31	4	3
				£6564	7	2

Library

Receipts	£	s.	d.
To Balance 1 May 1946	190	14	1
„ Interest in Investments (including Income Tax recovered)	52	15	3
„ Deposit Account Interest		5	9
„ Donations	121	0	0
„ Transfer from General Account	100	0	0
	£464	15	1

Fellows' Postal

Receipts	£	s.	d.
To Balance at May 1 1946	50	0	11
„ Deposit during year		6	0
	£50	6	11

YEAR ENDED 30 APRIL 1947

Meeting, 24 May 1947)

from 1 *May* 1946 *to* 30 *April* 1947.

Account

PAYMENTS	£	s.	d.	£	s.	d.
By Coal, Electric Current, and Gas				161	12	2
,, Repairs : Sundry				235	8	5
,, Taxes and Insurance				67	8	6
,, Miscellaneous Printing and Stationery				242	6	4
,, Petty Expenses and Postages				237	3	2
,, Publications :—						
Printing	1258	15	6			
Illustrations	70	3	9			
Distribution	65	11	8			
				1394	10	11
,, Transfer to Reserve for Publications Fund				1700	0	0
,, Salaries, Wages, etc.				1435	17	5
,, 'Zoological Record' (Vol. 82) Donation				15	0	0
,, Ray Society—Donation				5	0	0
,, Staff Annuities (Annual Premiums)				100	0	0
,, Purchase of £235 8*s.* 5*d.* 2½ per cent. Consolidated Stock (Compounders' Fees)				235	0	0
,, Transfer to Library Account				100	0	0
,, Balance at 30 April 1947 :—						
Current Account at Bank	81	1	5			
Deposit Account Post Office Savings Bank	541	18	7			
Cash in hand	12	0	3			
* Including £100 Composition Fees awaiting investment.				*635	0	3
				£6564	7	2

Account

PAYMENTS	£	s.	d.	£	s.	d.
By Periodicals				141	14	4
,, Binding				94	18	3
,, Books				58	16	5
,, Balance at 30 April 1947. Current Account	69	6	1			
,, Deposit Account Post Office Savings Bank	100	0	0			
				169	6	1
				£464	15	1

Account

PAYMENTS	£	s.	d.
By Postage during year			6
,, Balance at 30 April 1947	50	6	5
	£50	6	11

Separate Account

Receipts	£	s.	d.	£	s.	d.
To Balance at 1 May 1946 :—						
Westwood Fund	71	3	9			
Trail Award Fund	39	19	2			
Crisp Award Fund	62	15	4			
Hooker Lecture Fund	96	2	2			
Goodenough Fund	16	0	0			
Minchin Fellowship Fund	10	15	5			
Carnegie Corporation Grant	419	3	7			
Reserve Fund	1450	0	0			
Staff Pension Fund	3	10	9			
				2169	10	2
„ Transfer from General Account :—						
Reserve for Publications Fund				1700	0	0
„ Interest on Investments (including Income Tax recovered) :—						
Westwood Fund	10	17	4			
Trail Award Fund	3	10	0			
Crisp Award Fund	10	4	10			
Hooker Lecture Fund	21	18	0			
Goodenough Fund	8	12	8			
Minchin Fellowship Fund	3	15	0			
Staff Pension Fund	9	8	8			
				68	6	6
				£3937	16	8

Payments	£	s.	d.	£	s.	d.
By Goodenough Fund :—						
Transferred to Annual Contributions				21	10	0
„ Minchin Fund :—						
Transferred to Annual Contributions				8	0	0
„ Reserve Fund :—						
Return of Books and Collections from safe storage, etc.				62	12	4
„ Staff Pension Fund :—						
Purchase of £12 3*s.* 5*d.* 3 per cent. Savings Bonds 1955/65				12	19	5
„ Balance at 30 April 1947 :—						
Westwood Fund	82	1	1			
Trail Award Fund	43	9	2			
Crisp Award Fund	73	0	2			
Hooker Lecture Fund	118	0	2			
Goodenough Fund	3	2	8			
Minchin Fellowship Fund	6	10	5			
Carnegie Corporation Grant	419	3	7			
*Reserve Fund	1387	7	8			
†Reserve for Publications Fund	1700	0	0			
				‡3832	14	11
				£3937	16	8

* Expenses for Shelving for Library and for Decorations have been incurred to the estimated amount of £925, but not yet paid.

† Amount set aside to meet cost of Publications in hand.

‡ Including £3800 in Post Office Savings Bank.

Investments on 30 April 1947

General Account

£	s.	d.			Market Value 30 April 1947. £	s.	d.
1000	0	0	3½ per cent. London County Consolidated Stock 1958–68	@110½	1105	0	0
1000	0	0	Great Western Railway 4 per cent. Debenture Stock	@124½	1245	0	0
312	0	0	London Midland & Scottish Railway 4 per cent. Preference Stock	@ 80½	251	3	2
338	6	8	3½ per cent, War Stock	@105½	356	18	10
1000	0	0	3 per cent. Defence Bonds	@100	1000	0	0
2199	18	6	4 per cent. Australian Stock 1961–64	@117	2573	18	2
200	0	0	3 per cent. War Stock 1955–59	@106½	213	0	0
1139	13	0	3 per cent. Savings Bonds 1955–65	@106	1208	0	7
2310	16	10	2½ per cent. Consolidated Stock	@ 95	2195	6	0
176	19	3	3 per cent. Savings Bonds 1960–70	@106	187	11	7
					£10335	18	4

Library Account

£	s.	d.			£	s.	d.
450	0	0	Forth Bridge Railway 4 per cent. Stock (Bentham Bequest)	@103½	465	15	0
103	12	5	Surrey County 3 per cent. Stock 1961–66 (Wakehurst Bequest)	@106	109	16	9
191	12	7	4 per cent. Australian Stock 1961–64 (Walker & Morey Bequests)	@117	224	4	1
107	2	1	2½ per cent. Consolidated Stock (Stebbing Bequest)	@ 95	101	15	0
530	0	0	3 per cent. Savings Bonds 1960–70 (Tagart Bequest)	@106	561	16	0
					£1463	6	10

Separate Account

	£	s.	d.			£	s.	d.
£1063 10 7	232	5	0	Metropolitan Water Board 3 per cent. " B " Stock (Westwood Bequest)	@101	234	11	5
	667	14	2	Ditto ditto (Hooker Lecture Fund)	@101	674	7	9
	163	11	5	Ditto ditto (Goodenough Fund)	@101	165	4	1
	100	0	0	New South Wales 3½ per cent. Stock 1930–50 (Trail Award Fund)	@103	103	0	0
	409	11	1	2½ per cent. Consolidated Stock (Crisp Award Fund)	@ 95	389	1	6
£380 10 6	156	7	2	„ „ „ (Westwood Fund)	@ 95	148	10	10
	74	14	6	„ „ „ (Hooker Lecture Fund)	@ 95	70	19	9
	149	8	10	„ „ „ (Goodenough Fund)	@ 95	141	19	4
	260	5	2	3 per cent. Savings Bonds 1955–65 (Staff Pension Fund)	@107½	279	15	7
	100	0	0	„ „ „ 1960–70 (Minchin Fund)	@106	106	0	0
				F. C. STERN, *Treasurer.*		£2313	10	3

We have (in conjunction with the Professional Auditors, who certify as to all details) audited the Accounts of the Society for the year ended 30 April 1947 and found them correct. We have verified the Investments and Bank Balances.

Dated this 14th May 1947.

W. B. KEEN & Co., *Chartered Accountants*,
Finsbury Circus House,
Blomfield Street, London, E.C.2.

G. R. DE BEER,
A. H. G. ALSTON,
B. BARNES,
I. HENRY BURKILL,
H. W. PARKER,
E. M. WAKEFIELD.
} *Audit Committee.*

THE PRESIDENT'S REVIEW

We are honoured to-day by the presence of His Excellency the French Ambassador, who has kindly consented to attend our Meeting at which it has been my privilege to present the Linnean Medal to his illustrious countryman, Professor Caullery, who, as I need not remind you, is also one of our most distinguished Foreign Members. We welcome them heartily, as also M. Varin, the Cultural Counsellor of the French Embassy, M. Audra, Director of the French Institute in the United Kingdom, and Dr. Chabanaud. We are also glad to welcome among us Professor Sosa, who is Cultural Attaché of the Embassy of Uruguay, our Foreign Member, Professor Boschma of the University of Leiden, and his colleague, Dr. Pettersson, Member of the International Committee on Oceanography.

A countryman of Professor Boschma and a zoologist of great distinction is also among us, Professor Woerdeman of Amsterdam, and we are very glad to see him.

My first and very pleasant privilege and duty is to announce to the Society that the Officers have, in the name of the Society, addressed a message of humble duty and loyal greetings to **Her Majesty Queen Mary**, Honorary Member, on the occasion of Her Majesty's eightieth birthday, which falls on Monday next, 26 May. Queen Mary has been an Honorary Member of our Society since 1927 and I know that all here present will wish to associate themselves with this message :—

Major John Wickham, M.V.O.,
Marlborough House,
London, S.W.1.

Sir,

The President, Council and Fellows of The Linnean Society of London in general assembly on the occasion of the Anniversary Meeting, desire to express to their Honorary Member, Her Most Excellent Majesty Queen Mary, their Loyal Greetings and Humble Duty on the anniversary of Her Majesty's birthday on 26 May 1947.

Her Majesty has honoured this Society by being one of its Honorary Members since 1927.

We are, Sir,

Your obedient Servants,

G. R. de Beer, *President*,
F. C. Stern, *Treasurer*,
Malcolm Smith,
B. Barnes, } *Secretaries*.

L.S.

[The following reply to this message has since been received :—

Marlborough House,
S.W. 1.
26th May 1947.

Dear Sirs,

I have had the honour of laying before Queen Mary the letter signed by your President, Treasurer and yourselves on behalf of the Linnean Society of London, and I am commanded to ask you to be so good as to convey to the President, Council and Fellows of the Society in general assembly at the Anniversary Meeting an expression of Her Majesty's

sincerest gratitude for the kind words of their message on to-day's anniversary of her Birthday. Queen Mary greatly appreciated their remembrance of this occasion.

Yours very truly,

[signed:] JOHN WICKHAM,

Private Secretary to H.M. Queen Mary.

The Joint Secretaries,
Linnean Society of London.]

I have a further announcement to make which gives me the greatest honour and pleasure. The Fellows will remember that by the Bye-Laws of the Society, Chapter 3, special provision is made that the number of Honorary Members shall not exceed four, besides such Members of the Royal Family as may express a wish to belong to the Society. I now inform the Society that **Her Royal Highness the Princess Elizabeth**, F.R.S., has, by the message which I am about to read, conferred upon the Society the great honour of expressing this wish, and we now acclaim her as our new Honorary Member by rising in our places.

BUCKINGHAM PALACE,
21st May 1947.

Dear Professor,

Your letter to Sir Alan Lascelles was passed on to me, and I have this morning had the honour of laying it before The Princess Elizabeth.

I am desired to say that Her Royal Highness would be most pleased to accept the Honorary Membership of your Society.

The Princess was so interested to see the books which you enclosed with your letter.

Yours sincerely,

[signed:] MARGARET SEYMOUR,

Lady-in-Waiting.

Professor G. R. de Beer, F.R.S.,
Linnean Society of London,
Burlington House,
Piccadilly, W.1.

Meetings.

The one hundred and fifty-ninth session of the Linnean Society, now drawing to a close, has seen a full programme of meetings, at which the high attendance of Fellows and guests has been very gratifying. The gratitude of the Society is certainly due to the work of the Secretaries and the Assistant Secretary in planning and organizing these meetings. I should like especially to draw attention to two of these; the discussion on the teaching of taxonomy, held in conjunction with the Systematics Association, and the discussion on Algae. So successful were these in bringing forward points of general interest that the Council have resolved to hold more meetings of this type during the forthcoming Session. With regard to the teaching of taxonomy, the Council has decided to make a start by offering to organize a course of lectures on the principles of taxonomy, to be held in these rooms and illustrated with specimens and books from the Linnaean collections and library.

Library.

The treasures of the Society have now all been returned to the Society's rooms from their war-time places of safety. About 3000 volumes have been returned from the Bodleian Library; and the Archives and Miscellaneous Manuscripts from Simpson, near Bletchley, where they had been in the care of Mr. Warren R. Dawson, F.S.A. The Society will wish to express its gratitude to Bodley's Librarian and to Mr. Dawson for the protection which they so generously extended to the Society's possessions.

The scheme drawn up by the Library Committee for the reorganization of the Library is now being carried out. The installation of steel shelving in some new library annexes has been completed, and they will accommodate some 15,000 volumes, which will relieve some of the congestion from which no healthy library is free.

A sub-committee, appointed to rearrange the Society's collection of portraits, has gone about its difficult task with zeal and taste, and its recommendations have been implemented.

Among the donations received by the library is that from the Royal Horticultural Society of the magnificent work on Paeonies by our Treasurer, Colonel Stern. I should like to take this opportunity of thanking the Royal Horticultural Society and of congratulating Colonel Stern on his beautiful book.

Publications.

The publications issued by the Society during the Session include two parts of the Proceedings, one Journal, 'Zoology', and one Journal, 'Botany'. Of the Synopses of the 'British Fauna', two further numbers have been issued. Both of these, written by Mr. A. E. Ellis, are concerned with groups of Mollusca. Two more, of which one by the late Dr. Leo Cernosvitov and Dr. A. C. Evans is on Lumbricidae, and the other by Mr. D. M. Reid on the Talitridae, are in the press. Since 1944 five of these useful Synopses have been published; and it has been due to Mr. Reid's interest and zeal that these have appeared during difficult times. Synopses of other groups are now in course of preparation and it is hoped that these will appear in the near future.

The Council of the Society has reluctantly come to the conclusion that an increase in the cost of publications is now inevitable, and measures have been taken accordingly. These measures will not affect the Fellows, whose subscription rates remain unchanged, but only the public.

Fellowship.

The Society will have heard from the Assistant Secretary's Report that the number of Fellows now stands at 668. This means that 100 new Fellows are required to bring the Society back to the position which it occupied before the War. I wish to make an especial appeal to Fellows to assist in finding these new recruits. Far from wishing to reduce the standards required for candidature, it is my determination to maintain it. I am convinced, however, that many suitable candidates exist, and that they would not only benefit the Society but also themselves by applying for and receiving the Fellowship. It is necessary in each case to make a personal approach, and it is my earnest hope that the Fellows will not neglect this important service to the Society.

On more than one occasion during the Session, I have, as your President, been approached by various bodies and persons concerned with the preservation of the amenities of the countryside to take such steps as were appropriate in supporting them. With this object in view, I have thought it right and proper to communicate with the Minister of Town and Country Planning, on behalf of the Society, to express our grave concern at the proposed enclosure of many areas in the British Isles as training-grounds for the Forces. In particular I deplored the enclosure of areas that contain examples of rare plants and animals,

the continued existence of which might be endangered by the proposed occupation of their habitats as training-grounds, and I drew attention to the harmful results that would inevitably attend the loss of facilities for visiting and studying such areas.

Finally I wish to express my sense of gratitude for the loyal help and support which I have enjoyed from the Vice-Presidents, the Treasurer, the Secretaries, Assistant Secretary and Staff of the Society.

The PRESIDENT then delivered his Address on 'How Animals hold their Heads'.

On its conclusion, Lt.-Col. R. B. SEYMOUR SEWELL, C.I.E., F.R.S., moved 'That the President be thanked for his excellent Address, and that he be requested to allow it to be printed and circulated amongst the Fellows'. The motion was seconded by Mr. W. S. ROWNTREE, and being put to the meeting was carried with acclamation.

A film entitled 'The development of the Sperm cells of the Grasshopper' was then shown; and Dr. C. D. DARLINGTON, F.R.S., contributed a commentary on it. The President thanked Dr. Darlington.

The PRESIDENT then declared the Session of 1946–47 ended.

PRESIDENTIAL ADDRESS

By PROFESSOR G. R. DE BEER, F.R.S., P.L.S.

HOW ANIMALS HOLD THEIR HEADS.

(With 19 text-figures.)

The subject which I have chosen for the customary Address this year lays no claim to authoritativeness; it is not a wide synthesis of the state of knowledge reached in any particular field; nor does it pretend to any particular intrinsic importance. I have preferred to take my audience into my confidence and to go, with them, through the results of a few observations and experiments which I have made and conducted myself during the past few months. The subject is a very simple one: how animals hold their heads; in fact so simple that few have considered it worth their while to pay attention to it. I have selected it as my subject for today, not only because it has interested me but also for another reason, closely connected with the constitution and membership of this Society. The Linnean Society occupies a position, perhaps unique, in that it combines the interest and points of view of the systematic and the academic biologist, the professional, the naturalist and the amateur. Collaboration between all these types of biologists is of the highest importance for the successful prosecution of our science, and in what I have to say I hope that I shall succeed in making it clear that the amateur will have as much, if not more, to contribute than the professional.

My own interest in the problem of the posture of the head in animals arose from some work which I had previously done in connexion with the development of the skull.

It is well known that on each side of the head vertebrate animals have three semicircular canals, orientated at right angles to one another, in the three planes of space, movements in any or all of which are appreciated by the appropriate canals.

The planes of the canals are easily discernible in the skulls, both of embryos and of adults, since they are enclosed within the cartilage or bone of the auditory capsule. I am going to concern myself only with the pair of semicircular canals known as the lateral or horizontal pair, and the first thing which

excited my curiosity was the fact that, during development, the plane of these canals underwent a change relatively to the plane of the base of the skull. This was interesting in itself, showing that the plane of the canal in the adult animal is only reached as a result of certain modifications during development, and must presumably have a meaning. This became all the more probable when I realized that while the rotation of the plane of the lateral semicircular

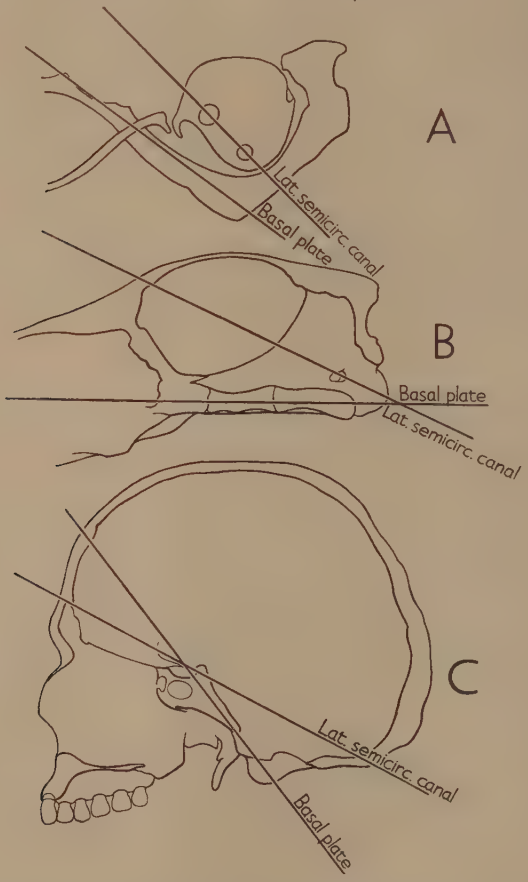

FIG. 1.—Diagram showing the relations between the plane of the lateral semicircular canal and the plane of the floor of the skull (basal plate) in
A. The embryonic condition (chondrocranium of rabbit), with the planes almost parallel ;
B. Adult horse's skull, with the plane of the lateral semicircular canal rotated clockwise relatively to the plane of the basal plate when seen from the left side ;
C. Adult man's skull, with the plane of the lateral semicircular canal rotated counter-clockwise relatively to that of the basal plate when seen from the left side.

canal relatively to the plane of the base of the skull took place in one direction (clockwise when seen from the left side) in most mammals, in others, including man, it took place in precisely the opposite direction (counter-clockwise when seen from the left side).

There must be clearly some good reason why, during development, animals go to so much trouble to rotate the planes of their lateral semicircular canals,

and the obvious hypothesis to invoke is one which has been invoked by Girard in France and by Lebedkin in Russia, namely, to suppose that the rotation takes place in such a way that the result is to leave the lateral semicircular canals in the horizontal plane when the animal is adult.

This apparently simple hypothesis in fact, however, presupposes a very important corollary, which is that animals have a characteristic and constant position of holding their heads. Previous workers, including those whom I

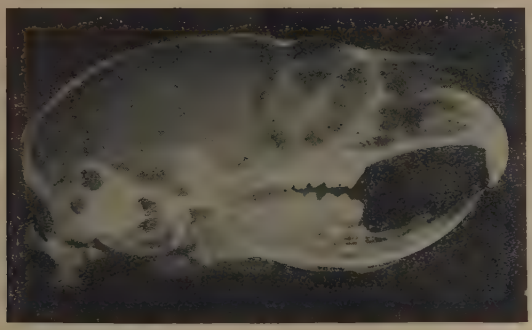

FIG. 2.—Radiogram of skull of adult mouse, showing the planes of the lateral semicircular canal and of the basal plate.

(*By courtesy of Prof. Amoroso, Royal Veterinary College.*)

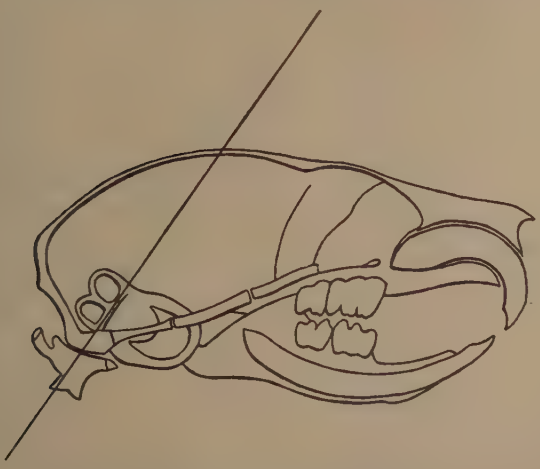

FIG. 3.—Outline projection of fig. 2. A straight line is drawn through the plane of the lateral semicircular canal.

have named, did not hesitate to start from the assumption that animals do in fact hold their heads in such a position that their lateral semicircular canals are horizontal. But this was taking for granted precisely what I wanted to prove. And, as I shall be able to show, there was a considerable surprise in store.

It has been known ever since the magnificent researches of Magnus that the nervous and muscular mechanisms of the bodies of animals are so arranged that when the position of the body of an animal is artificially upset, the muscles

are automatically stimulated to contract and extend in such a way as to restore the head to its original position, and it is also known that the ear is responsible for starting the chain of stimuli which result in this rectifying mechanism. It had, however, not been shown whether the position to which the head is restored in this way is the one in which the lateral semicircular canals are

FIG. 4.—Photograph of live mouse in state of alertness against a plumb-line.

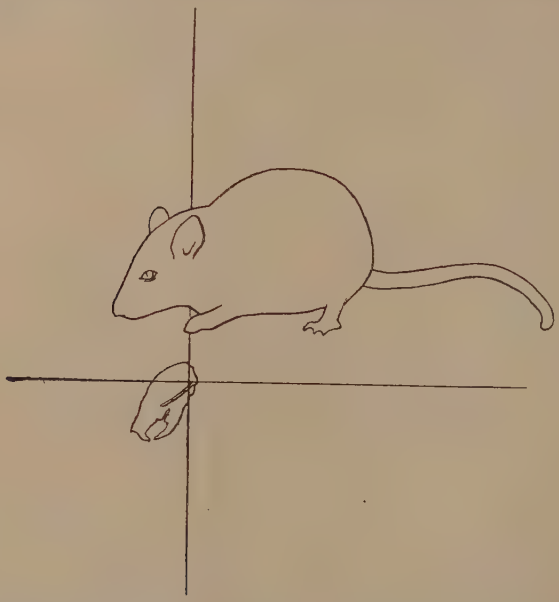

FIG. 5.—Assemblage of live mouse on vertical axis of plumb-line and mouse skull with plane of lateral semicircular canal drawn at right-angles to plumb-line. In the position of alertness the mouse therefore holds its head in a position in which the plane of the lateral semicircular canal is approximately horizontal.

horizontal. It was therefore necessary for me to determine what is the plane of the lateral semicircular canal in an animal, whether the animal has a constant characteristic position in which it holds its head, and what, at that position, is the plane of its lateral semicircular canal relatively to the horizontal.

A further question which at once arises is the state of the animal when it adopts this position. I have assumed that it must be a state of alertness, but it might be alertness to smell, to sound, or to sight. For reasons which I shall give later, I think that it is alertness to sight that is concerned here. Meanwhile this digression will serve to introduce a fact of some significance; viz., that the problem introduces us to a great many fields; in this case to those of sense-physiology and to the bionomics and behaviour of the animals.

The ideal procedure would, of course, be to take an X-ray photograph of the living animal, in a state of alertness, against a plumb-line, so as to gather

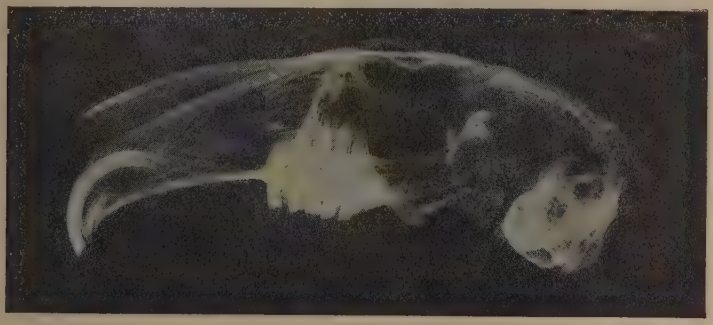

FIG. 6.—Radiogram of skull of adult rabbit, showing the plane of the lateral semicircular canal.

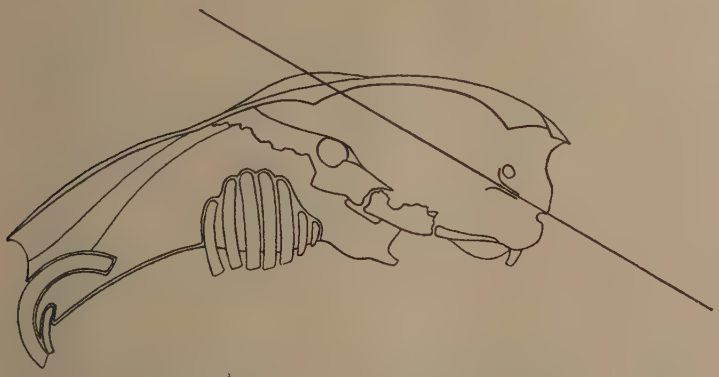

FIG. 7.—Outline projection of fig. 6. A straight line is drawn through the plane of the lateral semicircular canal.

all the required information on one negative. This is, however, not practicable, and it is necessary to proceed by instalments. First of all, the plane of the lateral semicircular canal can be determined in the skull by X-rays; next, the normal position of the head of the alert animal can be determined by ordinary photography against a plumb-line; and finally, the two results can be combined on one diagram in order to see what angle the plane of the lateral semicircular canals makes with the plumb-line.

Fig. 2 is a radiogram of a mouse skull in which the plane of the lateral semicircular canal is easily discernible, and in fig. 3 it has been projected on to an outline drawing. Fig. 4 is a photograph of a live mouse in what I believe to be its normal alert position, taken against a plumb-line. Fig. 5

FIG. 8.—Photograph of live rabbit in state of alertness against a plumb-line.

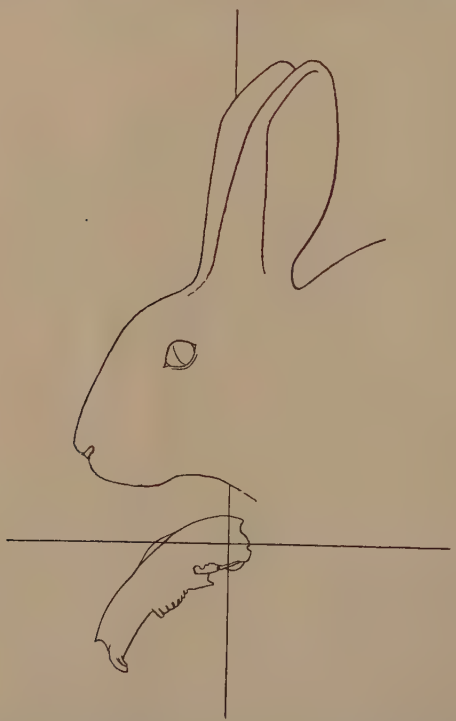

FIG. 9.—Assemblage of live rabbit on vertical axis of plumb-line and rabbit skull with plane of lateral semicircular canal drawn at right-angles to plumb-line. In the position of alertness the rabbit therefore holds its head in a position in which the plane of the lateral semicircular canal is approximately horizontal.

is an assemblage of the information provided by the radiograms of the skull and by the live mouse, made in such a way that the plane of the lateral semicircular canal is orientated at right-angles to the axis of the plumb-line. It will be seen that the outline of the skull fits well into the outline of the head of the live animal, and I therefore conclude that the lateral semicircular canal is approximately horizontal in the live animal. I say approximately, for, with the simple methods used, a perfect degree of accuracy cannot be expected. In addition, it has to be assumed that the structure of the live mouse was similar to that of the skull, which I have no serious reason to doubt.

The next set of figures repeats the same technique on the rabbit. Fig. 6 is the radiogram ; fig. 7 is the projection of the plane of the lateral semicircular canal on to the line drawing ; fig. 8 the live rabbit, and fig. 9 the assemblage, which again shows that the plane of the lateral semicircular canal is approximately horizontal in the live rabbit.

In larger animals, in which the bone of the skull is thicker and more opaque, it is not practicable to make out the plane of the lateral semicircular canal in the skull by means of X-rays. I have therefore had to have recourse to the method of dissection, which is not only more laborious, since the canal has to be exposed by a dental drill and a coloured bristle passed through the canal, but also more liable to error. However, such as it is, fig. 10 shows the outline of the skull of the horse as seen in a view from the medial side of the left half of the skull, with the plane of the lateral semicircular canal

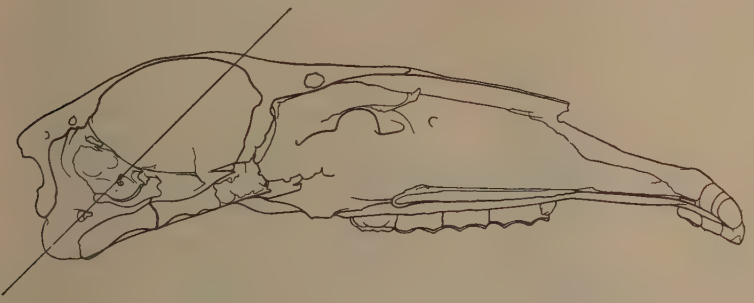

Fig. 10.—Outline drawing from medial side of left half of skull of adult horse. The plane of the lateral semicircular canal has been made out by dissection and is projected on to the drawing.

projected on to it. Fig. 11 is the live horse with the corner of a wall conveniently serving as a plumb-line ; and fig. 12 is the assemblage, again showing that the position of the lateral semicircular canal is approximately horizontal.

My next example is the dog. Fig. 13 shows a view from the medial side of the left half of a skull with the plane of the lateral semicircular canal, as determined by dissection, projected on to it. Fig. 14 is the live dog and fig. 15 the assemblage. The fit here is not quite so good, and I have the impression that the dog was looking slightly upwards when the photograph was taken, which means that in that position its lateral semicircular canals were sloping slightly backwards and downwards. This introduces yet another feature into the problem. For while in the other animals that I have described there does appear to be an approximation to the horizontal position for the plane of the lateral semicircular canals at positions of the head which I think can be reasonably described as those of normal alertness, the animals are of course capable of putting their heads into other positions. We shall have to see

FIG. 11.—Photograph of live horse in state of alertness against a vertical corner of a wall.

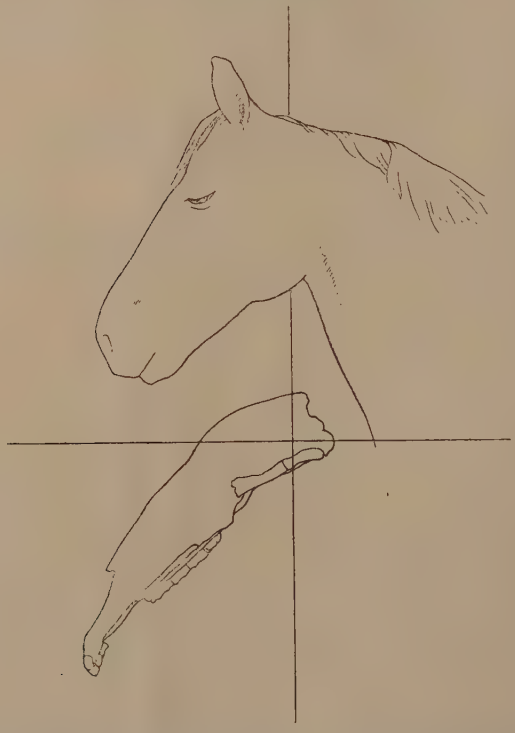

FIG. 12.—Assemblage of live horse on vertical axis and horse's skull with plane of lateral semicircular canal drawn at right-angles to the vertical axis. In the position of alertness, therefore, the horse holds its head in a position in which the plane of the lateral semicircular canal is approximately horizontal.

later whether this is less advantageous for them, but meanwhile we must note that in an intelligent and inquisitive animal like the dog, the plane in which the lateral semicircular canals is held is likely to be varied, particularly when it is sniffing and scenting.

When we come to man, the conditions are rather peculiar. The human skull does not permit of determination of the plane of the lateral semicircular canal by X-rays; nor does the human head lend itself easily to the superposition of an outline projection of the skull on a profile of the living subject,

FIG. 13.—Outline drawing from the medial side of the left half of the skull of an adult dog (greyhound). The plane of the lateral semicircular canal has been made out by dissection and is projected on to the drawing.

FIG. 14.—Photograph of live dog in state of alertness against a vertical corner of a wall.

owing to the lack of a long axis. The method which I have adopted is therefore indirect. First of all the plane of the lateral semicircular canal in the dry skull is determined by dissection, and projected on to a radiogram of the skull. Next, the so-called Frankfort plane is determined, the plane which passes through the lower border of the eye-socket and the upper border of the external auditory meatus. This is also projected on to the radiogram of the skull,

and the angle is measured between these two planes. The advantage of this is that the Frankfort plane is easily discernible in radiograms of the living subject.

Fig. 16 shows the plane of the lateral semicircular canal and the Frankfort plane as projected on to the radiogram of a dry skull. These planes make an angle of about 30°, and they are shown also in fig. 17, which is a view from the medial side of the left half of a skull. I am aware that there is variation in the angle which these planes make, as shown by the researches of Schönemann, albeit, by a very indirect method. After sawing out the bony auditory capsule

Fig. 15.—Assemblage of live dog on vertical axis and dog's skull with plane of lateral semicircular canal drawn at right-angles to the vertical axis. In the position in which the dog is holding its head, the plane of the lateral semicircular canal deviates slightly from the horizontal.

by a cut parallel with the Frankfort plane, filling it with Wood's metal and then dissolving away the bone, he found as much as 30° of variation between the plane of the lateral semicircular canal and the cut surface. By another method, using the position of the supra-orbital ridge as a standard, Girard found that the angle which the plane of the lateral semicircular canal made relatively to this ridge varied by 25°. On the whole, however, the general tendency of otologists, from Crum Brown to Watkyns-Thomas and Lowndes Yates, is to agree that the plane of the lateral semicircular canal in man usually makes an angle of 30° sloping downwards and backwards from what they call ' the horizontal '.

Now the Frankfort plane was adopted by anthropologists as the best practical approximation to the horizontal, but I cannot trace any actual experiments designed to show what in fact is the position of the Frankfort plane at ' normal positions ' of the head in man, nor what such a position is. I have accordingly conducted an experiment on ten students of my department. When dealing with the human subject it is very necessary to guard against any possibility

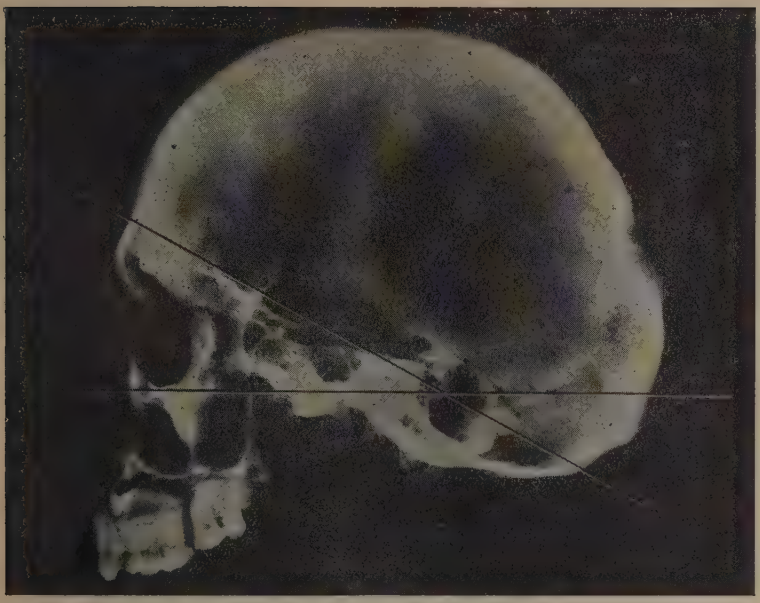

FIG. 16.—Radiogram of skull of adult man, showing the relation between the planes of the Frankfort line (passing through the lowermost border of the eye-socket and the uppermost border of the external auditory meatus ; both of which have been pointed on the skull by a piece of metal) and of the lateral semicircular canal which has been made out by dissection and projected on to the radiogram. These planes make an angle of approximately 30°.

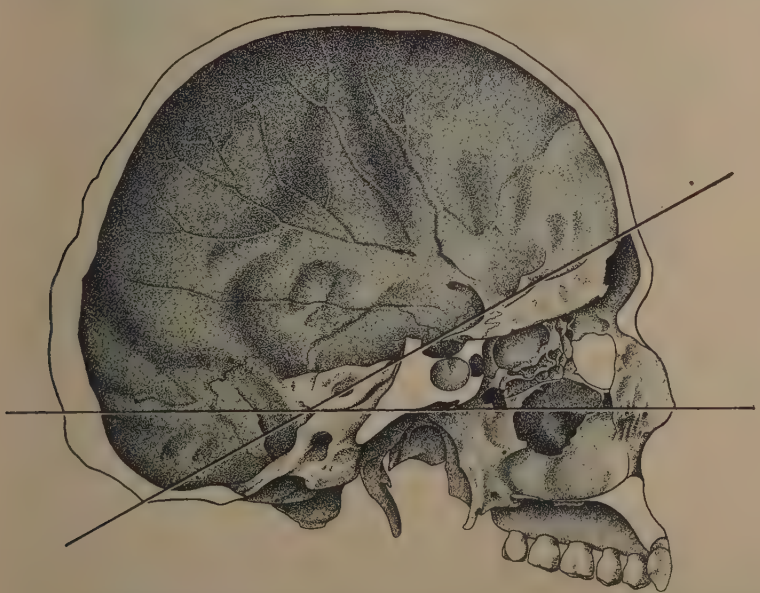

FIG. 17.—Drawing from the medial side of the left half of the skull of adult man shown in fig. 16, with the planes of the Frankfort line and of the lateral semicircular canal projected on to it.

of subjective influences interfering with the conditions of the experiment. If I had told them that I wanted to study the position in which they hold their heads, they would inevitably have posed. Some would have consciously tried to stand in what they considered to be the normal position; others, and especially those who have had military service, would have stood at the position of attention. I therefore adopted the expedient of concealing from them what my object really was, and I asked them to stand before the X-ray camera facing at right-angles to the axis of the camera, and to turn their heads towards the camera and back again. They were snapped as soon as they had turned their heads to their front, and they were then asked to say what mark their eyes were resting on upon a scale placed in front of them. By this means I obtained values not only for the angle between the Frankfort plane and the vertical plumb-line, but also for their angle of sight, since the height of the pupils of their eyes was also known.

FIG. 18.—Radiogram of living human subject in 'normal' position against vertical axis. The plane of the Frankfort line slopes 7° backwards and downwards from the horizontal; the plane of the lateral semicircular canal presumably slopes approximately 37° downwards and backwards.

The following are the results obtained :—

Serial number	Angle of sight	Angle between vertical and Frankfort plane
1	−7°	96°
2	−9° 30′	95°
3	−7° 30′	96°
4	−7° 30′	95°
5	−7°	84°
6	−7°	95°
7	−7° 30′	88°
8	−7° 30′	97°
9	−8°	87°
10	−9°	87°

Fig. 18 shows the subject with the maximum backward slope of the Frankfort plane, and fig. 19 the subject with the maximum forward slope of that plane.

It will be noticed that the Frankfort plane does not deviate by more than 7° below the horizontal or 6° above the horizontal. As a standard, therefore, the Frankfort plane is a good rough approximation to the horizontal position.

It is also to be noticed that in spite of the variation of the Frankfort plane to the horizontal, all the subjects showed a remarkable constancy in their angles of sight, not varying by more than 3°. It was presumed by Broca many years ago that the normal position of the head of an organism was that in which the eyes were directed on to the horizon. I am also informed by my friend, Dr. Nigel Cridland, that it is generally accepted by ophthalmologists

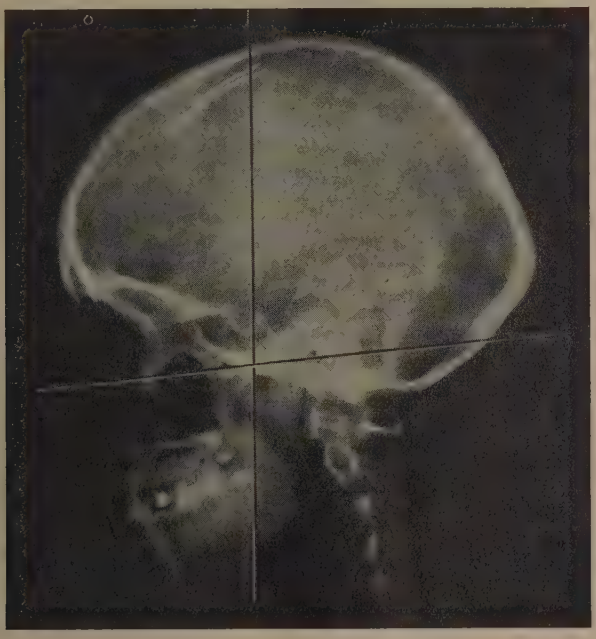

Fig. 19.—Radiogram of living human subject in ' normal ' position against vertical axis. The plane of the Frankfort line slopes 6° forwards and downwards from the horizontal ; the plane of the lateral semicircular canal presumably slopes approximately 24° backwards and downwards from the horizontal.

that the primary position of gaze is horizontal. The number of subjects on which I have worked is of course too small to base any far-reaching conclusions on the results, but it may be of interest to ophthalmologists to investigate it further.

Meanwhile, to return to the plane of the lateral semicircular canals in man, it will be seen that if that plane is taken as differing from the Frankfort plane by 30°, then its deviation from the horizontal will vary between 24° and 37°. In any case, and this is the important thing, if we leave out of account the variations between the plane of the lateral semicircular canals and the Frankfort plane (which cannot be determined in the living subject), at positions of the

head which appear to be normal in man, the plane of the lateral semicircular canals differ considerably from the horizontal, sloping backwards and downwards by something like 30°. It is therefore an error of fact for Lebedkin to claim, as he did, that this plane is horizontal.

If man wishes to place his lateral semicircular canals in the horizontal position, he must bend his head forwards and downwards. From the projection of the plane of the lateral semicircular canal on to the outline of the dry skull, Girard described the condition in man by saying that the plane of these canals would be horizontal if a man looked on to the ground at a point one or two metres in front of him.

The position of the plane of the lateral semicircular canals in man may perhaps be of special interest to anthropology in connexion with the descent of man from his pre-human ancestors, for in modern anthropoids the position of the foramen magnum is further back, and they stick their heads out forwards and downwards instead of balancing them on the top of a vertical neck. It is therefore possible that modern man may have retained something of the characteristics of his ancestors in the plane of the lateral semicircular canal.

The problem now arises, if mammals generally hold their heads in such a position that their lateral semicircular canals are horizontal, what advantage does it confer on them, and why does man differ and forego such an advantage? The answer to this problem entails a digression into some very important questions of sense-physiology and behaviourism. It might be thought, since the three semicircular canals on each side are at right-angles to one another, that it was immaterial what their exact orientation was, as movement in any direction in space would be resolved along one or more of their axes. It has, however, been shown, largely by the work of Dr. Löwenstein, that the sense-organs of a semicircular canal are in a condition of maximum reactivity when the motion to which they are subjected and respond is in the same plane as that of the canal. When an animal in a state of visual alertness turns its head and looks around, which is a reaction of the utmost importance to many animals in the detection of enemies, its sense-organs of balance will therefore function at their maximum efficiency if the lateral semicircular canals lie in the plane of such head-rotation, which will of course tend to be the horizontal.

There is an additional possible reason why this arrangement is beneficial. From the work of McNally and Tait on the functions of the sense-organs of the semicircular canals in the frog, the interesting result emerged that whereas the vertical canals produced a unilateral effect on the tonus of the muscles of the body, the lateral canals produced a symmetrical effect on the muscles of both sides of the body. The condition in which the lateral semicircular canals are horizontal is therefore the one in which the vertical canals will experience the least stimulation when the head is rotated. It would therefore be expected that there would be the minimum unilateral interference with the tonus of the body-muscles, and that, after a vigorous rotation of the head, the animal would not lurch sideways and fall over, as it might if its muscles were subjected to unilateral stimulation.

It would be expected therefore that defenceless animals which depend greatly for their safety on rapid scanning of the horizon, would show the closest approximation of the plane of the lateral semicircular canal to the horizontal. When it comes to the question why this state of affairs does not apply to man, the answer is no doubt connected with the greater variability of the plane of the lateral semicircular canal found in man. The mechanism is no longer of importance, and man relies more on visual stimuli to control his posture. It may also be less important for him to scan the horizon by rapid rotation of the head.

In other animals, however, and there is no reason to think that birds and reptiles will be found not to agree with mammals, it does appear, from those

which have been critically examined, that the plane of the lateral semicircular canal may reveal the position in which the animal holds its head. If this could only be established for a sufficiently large number of animals, there would be an interesting consequence for palaeontology. It might then be possible to determine how fossil animals held their heads, and in many cases, like those of the Dinosaurs and Titanotheres, this would be of considerable interest.

Now this is a field to which the amateur and the naturalist can contribute as much if not more than the professional academic biologist. What is required is the widest possible range of observations. The plane of the lateral semicircular canal can easily be found by a simple dissection of the skull. In bats no dissection is needed, for the canals are each enclosed in their own bony tube instead of being embedded in a compact bony capsule. In birds, the canals can be found with the greatest of ease, for the auditory capsule is composed of spongy bone which can be chipped away revealing the canals of harder material. The observation of the living animal requires a camera and a plumb-line. I should indeed be happy to think that these few remarks might lead to an extension of these observations by many others than myself, who would, I am confident, find such study a subject of interest.

I wish to thank many friends and collaborators for their help in this investigation, and in particular Professor Amoroso for the loan of the radiogram of the mouse's skull, Professor Cave for the gift of skulls and help in dissection, Mr. F. J. Pittock, A.L.S., for photographs, Mr. P. Venning for radiograms, Miss E. R. Turlington for drawings, and Mr. H. Barker and Mr. H. C. Bartle for laboratory assistance.

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Addendum.

Since delivering the Address printed above, I have had the opportunity of seeing the work of L. Girard, ' Port habituel de la tête et fonction vestibulaire ' (*Mammalia*, Paris, mars-juin 1947), in which the author develops the views expressed in his earlier paper. He states, and I have no doubt that in the case of many animals, he is correct, that at normal positions of the head the plane of the lateral semicircular canal is horizontal, but he presents no evidence in the form of photographs of live animals against a plumb-line that this is so.

EDMUND DAVALL, F.L.S., AN UNWRITTEN ENGLISH CHAPTER IN THE HISTORY OF SWISS BOTANY.—ADDENDUM.

By G. R. de Beer, F.R.S., Pres.L.S.

Since the publication of the paper on p. 42 of this volume, I have found a further document relating to Davall in the form of a letter from him to William Curtis, extracts from which were published by Mr. W. Hugh Curtis, F.S.A., in his delightful biography of William Curtis *. Through the kindness of Mr. W. Hugh Curtis, who has transcribed it, I now give this letter in full, for it supplies important information relating to the earlier period of Davall's life, before the start of his correspondence with Sir James Edward Smith.

'Mr Curtis at his Botanic Garden,
Near the Magdalen Hospital,
St George's Fields, London.

'With a parcel
of seeds.

'A lover of Botany unknown to Mr Curtis, yet who looks to him as his Preceptor, who owes what little progress he may have made in that delightful Study, in a very retired situation, First to his very perspicuous illustration of Linnaeus's Classes & Orders,—and afterwards to his charming demonstrations of Plants in the Flora Londinensis, returns him his most cordial thanks for his Instruction.—The seat of this Botanophilus's application has been hitherto a retired corner of Switzerland—the Contemplation of its rich Vegetation has been his chief delight & employment, & altho' his progress is retarded by extreme tenderness of sight, the reward of his solitary application has been the discovery of 5 species either not at all mentioned in Hallers great work or considered as doubtful Natives.

'Before he says anything more on that head he must observe that no other Motive can have led him to this Communication than an heart felt gratitude & the idea (judging from his own feeling) of its not being unwelcome :

'The Plants are the following —

1. Selinum Chabraei.
2. Tordylium maximum.
3. Geranium pyrenaicum.
4. Tragopogon majus.
5. Sonchus palustris.

3 & 5 are determined without any possibility of doubt by the Flora Londinensis & by culture—the others by the Flora Austriaca. Yet the seeds of 2 & 4 accompany this letter—those of 1. are not yet ripe.

'Others—but more especially the Professor de la Chenal of Basil—have discovered many other plants not in Haller which will be made known in the work which that Author prepares under the title of *Flora Helvetica* where the Swiss Plants will present themselves in an intelligible manner disposed according to the Linnaean System. The following are some of the new discovered inhabitants of Switzerland & not to be found in the Hist: Stirp.

'Scirpus Holoschoenus. Poa rigida. Athamenta pyrenaica Jacq: Ferula nodiflora. Laserpitium silaifolium. Oenanthe . . . nova. Seseli montanum & glaucum. Alisma ranunculoides. Euphorbia falcata. Potentilla alba. Lindernia pyxidaria. Draba pyrenaica. Ulex europaeus. Trifolium glomeratum. Trif: striatum.

'The Communicator is one of Mr Curtis's most devoted admirers—had he been less the sport of Fortune he might have declared himself his best Friend.

12th September, 1787.'

[The letter is endorsed 'Davall 87'. 'Switzerland 87'. It has a seal: Hand clasping a fleur-de-lys.]

* *William Curtis, 1746–1799* . . . Winchester, 1941.

BURCHELL'S RHINOCEROTINE DRAWINGS

By A. J. E. Cave, M.D., D.Sc., F.L.S.

(Plates 4 & 5 and 2 text figures.)

[Read 23 January 1947.]

William John Burchell, F.L.S., (1782–1863), undertook his classical exploration of southern Africa between the years 1811 and 1815. The exploits of 1811–12 were published in his *Travels* [1] illustrated by his own hand. In 1812 he made the acquaintance, not only of the then well-known Black Rhinoceros (*Rhinoceros bicornis* Linn.), but also of the hitherto scientifically unknown

TEXT-FIG 1.

(Copyright Gubbins Trustees)

'White', or Square-lipped, Rhinoceros (*Rhinoceros simus* Burchell), which he described [2] in 1817. Of the two species, Burchell, an accomplished draughtsman, made field studies of both living and dead animals. Two such sketches of the Black species were reproduced as woodcuts in Vol. II of the *Travels*, viz., a front view of the entire animal (p. 46) and a left lateral view of the head (p. 79). His other rhinocerotine drawings (save one sent to de Blainville in illustration of his type-description of the new species) remained unpublished. They are now the property of their custodians, the Gubbins Trustees of Johannesburg, and are preserved in the Main Library of the University of the Witwatersrand, Johannesburg. These drawings, of great

historical interest, reveal, far more than do any of the published woodcuts, Burchell's remarkable faculties of accurate observation and felicitous draughtsmanship. That they might therefore be accorded a wider recognition and appreciation than hitherto possible, the Gubbins Trustees have generously consented to their reproduction here. Mrs. Helen M. McKay, of Johannesburg, has most kindly provided photographs of the original drawings, together with sketch maps relevant to Burchell's itinerary, as well as numerous notes on the field location and subsequent fate of some of his rhinoceros specimens. To this indefatigable lady, and to the Gubbins Trustees, zoologists in general and Fellows of the Linnean Society in particular are therefore deeply beholden.

Burchell's Rhinoceros.

The ' White ', Square-lipped, or Burchell's Rhinoceros (*Rhinoceros simus* Burchell), is, after the elephants, the largest extant land mammal. It is distinguished externally from its congeners by its greater size, its square, non-prehensile upper lip, the truncated muzzle, the fleshy prominence anterior to the withers, the heavily fringed ears, the low carriage of the head, and the absence of skin folds. Apart from dentition and osteology, the internal anatomy of this creature remains unknown (as, indeed, does that of the Black Rhinoceros (*Rh. bicornis* Linn.)). The seemingly inappropriate name ' White ' does not refer to skin colour, but apparently derives by corruption from the Cape-Dutch word *widg*, meaning ' great ', ' huge '. A fast-vanishing species, Burchell's Rhinoceros is now restricted in range to the Lado region in the north and to parts of Zululand and Mashonaland in the south. Protection has probably come too late to save it from extinction.

Burchell encountered this Square-lipped species for the first time on the 16th October 1812, in the locality of Chué Spring (approximately lat. 26° 15′ S., long. 23° 10′ E.), on the Makuba Range, in the present Bechuanaland. (The type locality is indicated in the accompanying map (text-fig. 2)). He made several drawings of the animal in the field, which are reproduced here :—

(1) Pl. **4**, fig. 1.—*Rh. simus*. Sketchbook drawing 572. Oblique anterior view of living animal, showing the characteristic muzzle, lip, and stance. Pencil. Original 3½″×2½″. Executed 16th or 18th October 1812.

(2) Pl. **4**, fig. 2.—*Rh. simus*. Sketchbook drawing 573.

(*a*) Left lateral aspect of head. Inkwash, with dimensions and notes in pencil. Original 2″×1–7/10″. Executed 16th or 18th October 1812.

(*b*) Oblique anterior view of head, with certain dimensions added. Inkwash. Original 1–3/5″×1–1/5″. Executed 16th or 18th October 1812.

(*c*) Oblique postero-lateral view of detached head, without dimensions marked. Original 3½″×2″. Executed 16th or 18th October 1812.

(*d*) Left lateral aspect of dried skull. Labelled ' Mokhoru '. Pencil. Original 1–2/5″×1–4/5″. Executed 5th November 1812.

(3) Pl. **4**, fig. 3.—*Rh. simus*. Sketchbook drawing 572. Right lateral view of dead body of entire animal minus the feet, with certain dimensions and proportions marked thereon. Labelled ' Mokhōōhu '. Inkwash. Original, from tip of horn to edge of paper 6–4/5″×3–2/5″. (The feet are continued on the subsequent page of the sketchbook). Executed 16th October 1812.

In 1817 Burchell published, in French, a very brief description [2] of his new rhinoceros, mentioning its habitat, habits and principal external characteristics, and bestowing upon it the apt specific name of *simus*. He gives

FIG. 1.

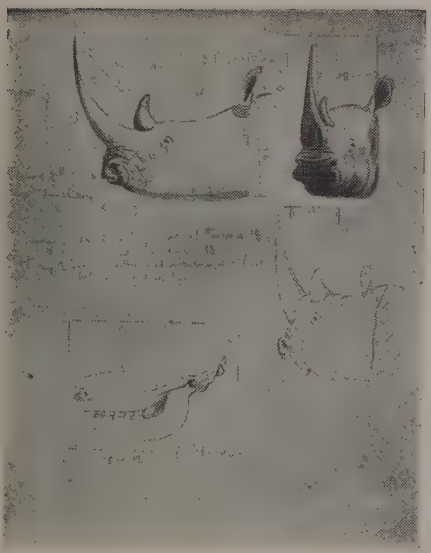


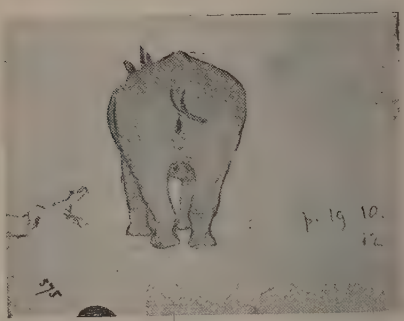
FIG. 2.

(Copyright Gubbins Trustees.)

FIG. 3.

Burchell's drawings of *Rhinocerous simus* Burchell.

FIG. 1.



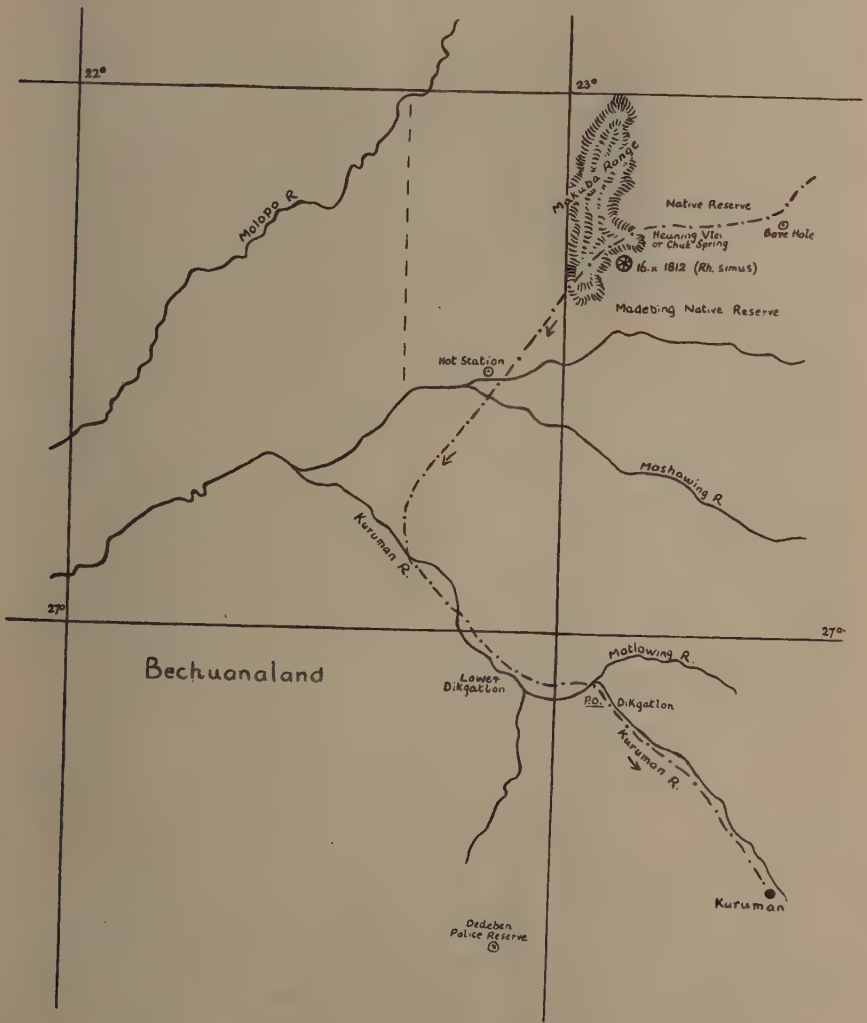
(Copyright Gubbins Trustees.)

FIG. 2. FIG. 3.

Burchell's field drawings of *Rhinoceros bicornis* Linn.

the native name(s), Mokhohu, Mokohu, Mokhoru, Mokhōōhu, for this species in his field drawings and in his *List of Quadrupeds* [3]. For the Black Rhinoceros (*Rh. bicornis*) he gives the native name of Killenjan (Killenýan) and the Cape-Dutch name of Rhenoster. This native recognition of two distinct kinds of rhinoceros may well have prompted Burchell's curiosity and effected that nice examination of the animals killed by his servants which resulted in

TEXT-FIG. 2.



scientific recognition of the specific status of the White Rhinoceros. For, in his memoir [2] establishing the formal zoological separation of the White from the Black species, he expressly states that, 'Ces deux animaux sont reconnus par les Nègres et par les Hottentots pour deux espèces très-distinctes, et portent chez eux des noms particuliers', and that he had 'assez d'occasions d'observer

les caractères qui les distinguent '. His observations confirmed the accuracy of the native recognition of two separate kinds of rhinoceros, the distinction between which lay ' principalement dans la forme de la bouche '.

Burchell provided a drawing (' soigneusement faite d'après nature ') of the head of *Rh. simus*, with the reproduction of which, apparently, de Blainville took liberties, for in a letter (Salisbury MSS., Linn. Soc.) to R. A. Salisbury, dated Fulham, 30th September 1817, Burchell complains that, ' In the plate of *Rh. simus* which Blainville has published in the *Bulletin des Sciences*, he has added, in my name, a pair of horns which I knew nothing about : nor can I guess for what purpose they were put there : they certainly are very different from the horns of *Rhinoceros simus*. So that you see my own endeavours at correctness are rendered fruitless '. The plate in question (unpaginated and inserted at some distance from the relevant text) displays, to the right, a ' Fig. I ', a woodcut depicting a left anterior-oblique view of the head. The orientation recalls that of the head of the animal shown in field drawing 572 (Pl. **4**, fig. 1, herein), but the anterior horn is very much smaller. Below the woodcut appears the legend, ' ad. nat. viv. delin. Wm. J. Burchell '. To the left of this cut appears another, (' Fig. II '), representing an isolated pair of rhinoceros horns, with some integument about the base of the hinder one, and, between them, two shaded ovals, probably cross sections. These adventitious horns doubtless represent some species other than *Rh. simus* and were presumably introduced by de Blainville for purposes of comparison ; but no legend accompanies them, and, as their specific identity is not intelligible from the figure, they remain anonymously inutile and merely detract from the Burchell figure. This last is itself decidedly inferior in artistic merit to the generality of the field drawings, so that the particular drawing submitted in illustration of the text would seem to have suffered somewhat in the process of reproduction. Altogether, Burchell's annoyance is understandable.

On his return-journey southward to the Cape from Chué Spring (*i. e.* after October 1812), Burchell began the collection of skins and odontological specimens of both ' White ' and Black species of rhinoceros. Of *Rh. simus* he presented to Oxford University Museum the following specimens :—

' *Cat. No.*

1562 Integument and snout with horns.
1563 Integument and snout with horns.
1564 First true molar, left side.
1565 Second true molar, left side.
1566 Third upper premolar, right side.
1567 Third upper premolar, left side.
1568 Second true molar.
1569 Third lower true molar, right side.
1571 F st lower true molar, left side.
1573 Horns '.

To the Museum of the Royal College of Surgeons he presented two teeth and a pair of horns. The reference numbers of these items are those of Flower's *Catalogue* [4], 1884 ; the ' O.C. ' (=Old Catalogue) comparison numbers are those of Owen's earlier (1853) *Catalogue*. The relevant entries are quoted verbatim in illustration of Flower's characteristic caution and his hesitancy regarding the specific attribution of the teeth :—

' *Cat. No.*

2155 The calcified but unworn crown of a left upper molar attributed to this species. O.C. 2959.

In the freedom of the extremities of the combing plates, which cut off no accessory valley, it most resembles *R. bicornis*.

2156 A much-worn tooth, said to be the posterior upper milk molar. O.C. 2960.

2157 Anterior and posterior horns. O.C. 2968.
The length of the front horn is 39 inches (99 cm.), its basal circumference being 26 inches (66 cm.) '.

These four specimens represent the entire rhinocerotine material received from Burchell; all perished in 1941 when the Hunterian Museum was severely damaged by enemy action.

The fate of the skull depicted in field drawing 573 (Pl. **4**, fig. 2, *d*) is unknown. It was not presented, with other material, to either the Oxford University or the Hunterian Museum, and most likely never left Africa. It must have been a heavy and bulky object, and it is significant that Burchell's rhinocerotine field drawings are concerned solely with objects (*e. g.* living animals, carcases, detached heads) impossible, or too difficult, of transport, whilst they ignore easily portable objects, such as horns and teeth. The probability is, then, that the type skull of *Rh. simus* was not preserved but was left in the field.

The Black Rhinoceros.

Burchell's men killed (for food) a total of 10 rhinoceroses, the majority being of the Common or Black species (*Rhinoceros bicornis* Linn.). Of these 10 animals, 6 only are traceable, viz :—

(A) White Rhinoceros (*Rh. simus*).
One, killed near Chué Spring, Bechuanaland, on 16th October 1812. (Burchell's drawings 572, 573, reproduced here in Pl. **4**, figs. 1, 2, 3).

(B) Black Rhinoceros (*Rh. bicornis*).
Two, killed in the region of Britstown (then outside the Cape Colony). (*Travels*, II, p. 75, and woodcuts pp. 46 and 79).
One, a female, killed in the region of Chué Spring (Heuning Vlei), Bechuanaland, on 19th October 1812. (Burchell's drawings 575, 576, reproduced here in Pl. **5** and text-fig. 1).
Two, a female and her calf, killed ' at Hot Station, on the Moshowa [Mashawing] River, in the Transgariepine ', *i. e.* S.W. of Chué, Bechuanaland. The young animal was presented to the British Museum, being item no. 11 (p. 4) in Burchell's *List of Quadrupeds* [3]. But no available permanent record, other than Burchell's printed *List*, details its acquisition, and recent search has failed to establish its survival.

Burchell's field drawings of the Black species are reproduced herein as follows :—

(1) Pl. **5**, fig. 1.—*Rh. bicornis*. Female. Sketchbook drawing 576. Left lateral view of living animal (that shown dead in text-fig. 1). Labelled ' Rhinoceros bicornis, fem. '. Pencil. ' Drawn from the measurement of half an inch to the foot '. Original, nose-tip to tail-tip 5–4/5″: horn-tip to ground 3½″. Executed 19th October 1812.

(2) Pl. **5**, fig. 2.—*Rh. bicornis*. Female. Sketchbook drawing 575. Front view of same living animal, showing characteristic prehensile upper lip and carriage of head. Labelled ' Killenjan '. Inkwash. Original 2–1/5″×1–1/5″: human figures in background respectively 9/10″× 3/10″ and 1″×½″. Executed 19th October 1812.

(3) Pl. **5**, fig. 3.—*Rh. bicornis*. Female. Sketchbook drawing 575. Hind view of same living animal, with dog to left. Inkwash. Original 2–3/10″×1½″: figure of dog 1½″. Executed 19th October 1812.

(4) Text-fig. 1.—*Rh. bicornis*. Female. Sketchbook drawing 576. Left lateral view of dead animal (depicted alive in Pl. **5**), with dimensions indicated. Inkwash. Original, nose-tip to tail-tip 6–7/10″; horn-tip to edge of paper 4″. Executed 19th October 1812. The hairless tail and some odd notes are shown separately and below, from the succeeding page of Burchell's sketchbook, headed ' Killenjan '.

To the Museum of Oxford University (which, in 1834, conferred upon him its D.C.L.) Burchell presented the following specimens relating to this species :—

' *Cat. No.*

1574 Snout with the horns attached.
1575 Mandible.
1575(*a*) Large horn of a Rhinoceros.
1575(*b*) Small horn of a Rhinoceros '.

To the British Museum, then at Bloomsbury, he presented, in 1817, the young animal already mentioned as shot at Hot Spring (' in company with its dam ') and which cannot now be traced.

The drawings reproduced here of the two rhinocerotine species manifest a naturalness and a vivacity altogether absent from Burchell's published figures. Their examination, especially if made with a hand lens, cannot fail to evoke profound admiration for his artistic ability, an admiration enhanced by recollection of the adverse conditions under which, perforce, the originals were made.

The writer's grateful acknowledgments are hereby tendered to the Gubbins Trustees, Johannesburg, for their courteous permission to reproduce the original drawings, to Mrs. Helen M. McKay for her enthusiastic and invaluable co-operation, and to Dr. F. C. Fraser, British Museum (Natural History), for his assistance in the scrutiny of records and specimens.

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OBITUARIES

Loftus St. George Byne was born at Teignmouth on 19 September 1872. He was educated at Bath College and Owens College, Manchester; after taking the degrees B.Sc. and M.Sc. he became a lecturer in chemistry. He was an enthusiastic collector of British marine shells; he explored Teignmouth Bay thoroughly with a dredge, and also collected in Cornwall, the Isle of Man and on other British shores. Increasing blindness forced him to give up his collections, which he disposed of in 1924. In the same year he resigned from the fellowship of the Linnean Society, to which he had been elected in 1914. He died at Exmouth on 19 June 1947. He wrote an account of the marine Mollusca of Teignmouth in the Journal of Conchology (1893, 1896) and on the corrosion of shells in cabinets, which he traced to butyric acid, in the same journal (1899, 1906), as well as some other papers. R. WINCKWORTH.

Edouard Pierre Léon Chatton was born at Romont, Switzerland, on 11 October 1883, and died at Banyuls on 23 April 1947, after a long and severe illness; we lose in him an eminent zoologist, who has left behind him an important and homogeneous contribution to his subject *.

He was, even as a child, very fond of natural history, and later he became a student at the Sorbonne, Paris. Soon afterwards he made interesting observations at Roscoff and at Banyuls. These brought me into touch with him, and I helped him to enter the laboratory of the Pasteur Institute, which was under the direction of F. Mesnil; there he learned the discipline of strict experimental methods. In 1914, when he was at the Pasteur Institute at Tunis, he was mobilized into the African Army. He was wounded in 1915, and, after recovery, he returned to Tunisia, where he organized a medical bacteriological laboratory at Gabès. In 1919, when peace had returned, he published a notable thesis for his doctorate on the Blastodinid Peridinians. He was then assistant professor of biology at the University of Strasbourg, and soon became ordinary professor. There he taught many students, some of whom are now well known as biologists. In 1932 he was transferred to the University of Montpellier, where the Marine Biological Station of Sète attracted him. In 1937 he became Director of the Laboratoire Arago at Banyuls, with the rank of professor of the Faculty of Sciences, Paris (Sorbonne).

Chatton's work is of first-rate quality, and notable because of the number and interest of the types which he studied—and often discovered—and because of the problems which he propounded and resolved. He worked chiefly at marine and parasitic Protozoa. His thesis for the doctorate in science is a masterpiece. It deals with those Peridinians for which he founded the group Blastodinidae, describing many new species and thoroughly clearing up their structure and development. He identified and described as well another entire group of Peridinians, really parasites in Radiolarians, but before his work, confused with Radiolarians. He contributed greatly to our knowledge of the structure of such organisms as *Polykrikos*, and published many interesting papers on parasitic and pathogenic Flagellates, on Amoebas and on Sporozoa (Sarcosporidians, *Siedleckia*, *Eleutheroschizon* and others).

His work on Ciliate Infusorians is particularly important. Chatton described many species of these creatures, and even established new families. I may mention his work on the Thigmotrichidae (parasitic on the gills of Molluscs), on the Apostomidae (recognized from cysts on moulting Copepods and studied throughout their life-histories), on the Pilisuctoridae (parasitic on the bristles of Crustaceans) and on other groups. He discovered such curious organisms as *Ellobiophrya*, on the gills of *Donax*, fixed there by an adaptive structure very like the attachment of an ear-ring.

* I mention here his notice, *Titres et travaux scientifiques* (Sète, 1937, 4to, p. 407), listing, to that date, 240 notes and more extensive publications.

We owe to him important and accurate experimental studies on the conditions of conjugation in Infusoria, in which he continued the classical work of Maupas, Calkins and other workers. He showed very clearly, in *Glaucoma*, *Colpidium* and *Paramecium*, that conjugation depends wholly on external conditions, such as the presence of certain chemical substances and on the pH of the medium.

During his work he made many observations of general interest on the cytology and structure of the Protozoa : mitosis in *Amoeba* and in Peridinians, and an analysis of the structure of flagellae and ciliae (cinetid, cinetome, infraciliature, cnidocysts, trichocysts, etc.).

Chatton's outstanding position as a protozoologist will be best appreciated by the circumstance that, before the outbreak of the last war, he was asked by the Germans to write a new edition of O. Bütschli's fundamental account of the Protozoa in Bronn's ' Klassen und Ordnungen des Tierreichs '.

He also printed many interesting observations on various Metazoa, especially parasitic Copepods.

Chatton was a persistent and conscientious worker. He has left many interesting observations which he thought were too incomplete for publication. During his career he worked with many collaborators, among whom may be mentioned André Lwoff, and he taught many students. As he was a good artist, he was able to illustrate his papers with many beautiful figures. He was still hard at work when war and sickness stopped him prematurely. Had this not happened, he would certainly have added many more interesting observations to his work. M. CAULLERY.

ON 30 November 1945, botanical science suffered a severe loss by the death of Professor **Ludwig Diels,** the Director-in-Chief of the Botanical Garden and Museum in Berlin—Dahlem. As a pupil and successor of Adolf Engler, he was in Germany the most prominent representative of systematic botany and plant-geography at a time when his professorial colleagues in the other universities were more and more devoting themselves to other branches of botany such as plant-physiology and genetics.

Ludwig Diels was born on 24 September 1874 in Hamburg as the eldest son of Hermann Diels, one of the masters of the Hamburger Grammar School, who, on the strength of his attainments in classical philology, was appointed to the University in Berlin, where he gained a high reputation and became the secretary of the Academy of Science. His gifts were inherited by his sons, the two younger ones were appointed as professors at two universities, one in Chemistry at Kiel, the other for Slavonic languages at Breslau. Ludwig grew up in Berlin, but never regarded himself as a native of that town, being proud of his Hessian ancestry. He was educated at the Joachimthal Grammar School, renowned for its humanistic training, and the tradition of his paternal home-life stimulated his natural gift for the spoken and written word. From 1893–96 he studied, in Berlin, geography and natural history, particularly botany, in which subject Ascheron, Krug, Magnus and Schwendener and more particularly Adolf Engler were his teachers. The latter soon recognized the special ability of his pupil and guided his studies in the direction of his own scientific interests. Consequently Diels's dissertation presented for the Ph.D. degree in 1896 dealt with the Biology of the Vegetation of New Zealand. In this thesis the dependence of the vegetation on climate is discussed and the effect of surrounding conditions on the morphology and anatomy is described. Similarly, in the article written by Diels as Engler's assistant, he discussed the adaptation of the vegetative organs of the African species of the genus *Rhus*. In the same period as Engler's assistant he published his first systematic monographs, in the first instance on the African Anonaceae and Combretaceae (together with A. Engler) and subsequently the article on the

ferns for Engler and Prantl's Pflanzenfamilien. These labours were accomplished in spite of multifarious duties, which Engler's incessant drive for work necessitated, and so represent a very considerable achievement.

On 18 June 1900 Diels became Lecturer in the University of Berlin, and in the same year he commenced the great voyage for the furtherance of his studies, which probably may be regarded as one of the great events of his life. With the help of a grant from the Academy of Science, and in the companionship of his friend Ernest Pritzel, he visited South Africa, West and East Australia and on his return journey the island of Java. On this voyage he gained from a personal study a deep insight into the nature and conditions of life of the most varied types of plants and plant associations and gained thereby a leading position among plant-geographers. His voyage also extended his knowledge of the world to a very considerable degree, gave him an insight into vast areas of the British Empire and made him familiar with the conditions of life in tropical colonies, where comparatively small numbers of Europeans formed the governing body of the coloured races. A remembrance of this period of his life, of which he spoke frequently and with great pleasure, gave him a certain predilection for English Art and the English language, and he was obviously always pleased when he had the opportunity of conversing in that language. The material results of that voyage were also considerable, consisting as they did in a large collection of dried plants as well as in much material preserved in alcohol. The main publication of his studies was the ' Pflanzenwelt of West Australia ' in Engler and Drude's ' Vegetation of the World ' (1906). Further observations made on this voyage led to a monograph of the Droseraceae published in Engler's ' Pflanzenreich ' and to a penetrating article entitled ' Jugendformen und Blüthenreife im Pflanzenreich ' (1906), in which he gave evidence of his desire to find a general law governing the individual manifestations of growth and development. A similar summary of his observations is also contained in his ' Pflanzengeographie ' in the Göschen publications (1908), a comparatively small volume, but which in its brevity indicates a master mind. Partly before and partly during these labours Diels undertook researches into the Flora of China, the results of which were published in a series of considerable length and which indicate his exceptional powers of work. These studies deal with the various divisions of the Chinese flora and their relations to the flora of Tropical Asia.

In 1906, Diels took over the duties of the Assistant Professor of Botany in Marburg and, in 1908, he was himself appointed Assistant Professor there, a post which he held until 1914. These early years in Marburg were perhaps the happiest in his life. Untrammeled by administrative duties he could devote himself wholeheartedly to the preparation of his lectures and to the enjoyable excursions with his students, and at the same time undertake his own private scientific investigations. He could also enjoy his young family life, having married a Berlin lady, Miss Gertrud Biesenthal, in 1906. Soon three flourishing children (one son and two daughters) were added to the household.

When, in Dahlem, the Assistant Director of the Botanical Garden and Museum, Ignaz Urban, retired, Diels was appointed as his successor and returned to Berlin (1914). Here he had to undertake many administrative duties and carried these out with great conscientiousness and remarkable success. The outbreak of the Great War did not affect him personally as he was not considered capable of military service owing to an injury to his skull, caused by a fall in the Alps. However, he published a book on the ' Ersatzstoffe aus dem Pflanzenreich ' which may be considered as his contribution to the needs created by the war.

When Engler retired from his duties, Diels was appointed as his successor in 1921 and was also appointed to a professorship in the University of Berlin. In 1928 he was given the title of Director-in-Chief of the Gardens and was

elected a Member of the Academy of Science. Thus he attained all the dignities open to him in his position. Abroad he was held in the greatest esteem. He was elected a corresponding and honorary member of many learned societies in Geneva, Helsinki, Copenhagen, Lund, Upsala, Oslo, Bukarest, London (Linnean Society, Royal Horticultural Society), Edinburgh, Calcutta, Perth (West Australia), Wellington (New Zealand), and in America in Cambridge (Mass.), New York, Chicago, Philadelphia and Washington. The greatest honour, however, was the Honorary Degree of D.Sc. which was conferred on him at the International Botanical Congress in Cambridge in 1930. Many foreign botanists too were attached to him as personal friends. At the height of his career he was able to carry out a plan he had long desired, by undertaking a journey to Ecuador, which he did in conjunction with a series of lectures he was invited to deliver in the United States. Here he was able to become acquainted with a great portion of the vegetation of North America. His journey in the Andes gave him a new and extensive insight into the vegetative conditions of equatorial mountains and resulted in an important publication in 1937.

On his return to Germany he found the conditions of life greatly changed by the assumption of power by the National Socialists. Rooted as he was in the philosophical faculty of the University and the Academy of Science, and endowed with a strong critical faculty inclined to scepticism, he was personally opposed to the brutal totalitarianism of the Nazi regime, but as director of a great national institute he had to acquiesce in much that he disliked. But it caused him much trouble and it required all his ingenuity to smooth all the difficulties which arose.

Then came the second world-war, and in addition to much senseless destruction there came an occurrence which must be regarded as a calamity for international systematic botany. On the night of 2 March 1943, during an aeroplane attack, the library and the most essential portion of the herbarium, the botanical museum and a portion of its irreplaceable type-specimens were destroyed by fire. How heavy this blow was for Diels, who from its first scientific beginnings was most intimately connected with this institute, can only be imagined, for towards the outside world he maintained the most wonderful self-possession. In the same way he had borne with stoical self-possession the death of his promising son, who, as a young officer, had lost his life through an accident to an aeroplane before the war.

In his heart of hearts he was terribly upset and robbed of his vitality. For those who were about him and knew him well it was most moving to see how he fought against the collapse of his powers, how, until shortly before his death, he still came constantly to the museum and tried to carry on his executive duties. On 30 November 1945 he passed away peacefully at the age of 71.

His life had been a continuously upward course without any setbacks, its end was a tragic fall; for the establishment which he had helped to build up with his great energy and faculties and which was so near his heart was almost completely destroyed. In addition the night of gloom into which Germany had been projected showed no ray of light and there seemed no hope that it would be able to be rebuilt. But the rich scientific work of Diels is preserved in his writings and should serve as an exhortation to those who come after him to build up again the destroyed edifice, even if it has to be on a more modest scale than the old one. It would be admirable if Diels's friends in foreign lands would help to do this.

By the death of Diels a many-sided and richly endowed investigator has passed away. He had a most agile mind and possessed an acute understanding but also an active imagination, which led him to recognize rapidly the value

and future possibilities of newly-arising problems and hypotheses. He was a skilful debater who knew how to keep up a conversation, and occasionally he loved to provoke a discussion by putting forward paradoxical assertions. In his academic lectures he showed himself to be an excellent speaker, who had a rich command of words and an agreeable voice which easily reached the listeners in large halls. He prepared his university lectures very carefully and was particularly keen about his botanical excursions, which took him and his students not only into the environs of Berlin but also further afield, as, for instance, into Thuringia. In the intercourse with his students he was very genial and, being an active pedestrian, he often tried the endurance of his younger companions. In carrying out the duties of Director of the Museum he was exemplary in his conscientiousness and punctual to the minute. In his relations with his staff he was free from any autocratic manner, he gave his assistants much freedom and independence in their work. His nature inclined him to be an example rather than a leader just as Engler had been.

His publications show, as did his lectures, the same lucidity, careful planning and great readableness. This is not the place to name them all, but a few, which are of special significance and which have not been mentioned in the preceding paragraphs may be cited as indicating his special lines of work. Most of them, of course, deal with systematic botany and are either monographs like the extensive treatment of the Menispermaceae for Engler's ' Pflanzenreich ' (1910) or collections of new descriptions like ' Fragmenta Florae Australiae Occidentalia ' (1905) and the ' Plantae Forrestianae ' (from China, 1911–13), etc. The experience gained in this work he has explained in his ' Methoden der Phytographie und Systematik ' in ' Abderhalden's Handbuch der Naturwissenshaftlichen Arbeitsmetoden '. The publications dealing with plant-geography include ' Genetische Elemente der Flora der Alpen ' (1910), ' Flora der Zentral-Sahara ' (1917), ' Kontinentalverschiebung und Pflanzengeographie ' (1928), ' Die Flora Australiens und Wegeners Verschiebungs theorie ' (1934), ' Austrahlungen des Holarktischen Florenreiches an seinem Südrand ' (1941), ' Bericht über die Vegetations Kunde von Deutschland 1930–40 ' (1943). Some ecological articles deserve special attention, as they indicate the many-sidedness of their author's interests. They include observations made during a vacation on the ' Algenvegetation der Südtiroler Dolomitriffe ', which deals with the so-called inky streaks on the rock walls of the Dolomites caused by endolithic Algae. In addition may be mentioned ' Kaeferblumen ' (1917), ' Rhytmik and Verbreitung bei den Brennen des Somerwaldes ' (1918), which were studies of the Marburger time. Thus Diels has left behind him rich treasures of his life's work, which will keep alive the remembrance of him everywhere where scientia amabilis is studied.

J. Milbraed and R. Pilger.

[*Note*.—The Society is indebted to Professor F. E. Weiss, F.R.S., for translating the above obituary notice from the German manuscript.]

Botany in general and Plant Physiology in particular is poorer by the death on 22 February 1947, of Professor **Ludwig Jost** in his eighty-second year. But though weak in body, partly owing to malnutrition during the post-war years, his mind remained active and he greatly regretted his inability to continue his physiological investigations.

Born in Karlsruhe in the Grand Duchy of Baden, Jost was educated at first in the local Grammar School passing on into the Friederich Schule, a special branch of the Grammar School, which the enlightened Grand Duke Frederick had founded and supported so that his sons should be educated together with the sons of private citizens.

Jost passed his matriculation examination in the autumn of 1883 and entered the university of Heidelberg to study the natural sciences, attending

more particularly the lectures of Bütschli and of Pfitzer. Two years later he proceeded to Strassburg to study under de Bary. In 1887 he took his doctor's degree, presenting for the same a thesis on breathing-roots of palms. In addition to Botany he had been attending lectures in Physics and Zoology.

During the summer of 1887 he acted as assistant to Goebel in Marburg, but returned to Strassburg in the autumn as assistant to de Bary; when the latter died in 1888 Jost became assistant to de Bary's successor, Count Solms-Laubach. In 1891 he qualified for the office of lecturer in the university by presenting a thesis on sulphur and saltpetre bacteria. Two years later he was appointed Reader (extraordinarius) in the University of Strassburg and in 1907 professor of botany in the University of Bonn. In 1908 he was called to fill the professorship in Strassburg, where he remained until the end of the first World war, acting as rector of the University in 1916. When in 1918 the French re-occupied Strassburg, Jost had of course to leave the university. Fortunately for him the professorship of botany in Heidelberg became vacant and he was appointed to it. He held this post until 1934 and on retiring from it was elected emeritus professor. He continued, however, his private investigations in the Kaiser Wilhelm Institute in Heidelberg until 1942, when ill-health brought to an end his scientific activities, to his great regret.

Though not taking any active part in politics Jost was a consistent opponent of the Nazi regime in Germany and on more than one occasion expressed privately his abhorrence of Hitler's persecution of the Jews.

Having studied under so many first-rate botanists, Jost's outlook on botany was a wide and varied one. He dealt with both the morphological and physiological aspects of botany, as can be gathered from the following titles of some of his publications.

'Growth in thickness and the formation of annual rings'.
'Relationship between the formation of leaves and the vascular system of plants'.
'The peculiarities of the cambium of trees'.
'The formation of the net of *Hydrodictyon*'.
'The physical properties of the protoplasm of *Valonia* and *Chara*'.
'Nyctritropic movements'.
'The self-sterility of some flowers'.
'The physiology of the germination of pollen'.
'Studies in geotropism'.
'The dependence of the leaf on its assimilatory activity'.

In his later life most of Jost's researches were of a physiological nature, as was also his magnum opus the 'Lectures on Plant Physiology, first published in 1904. It was so successful and useful, that four editions were called for. It was translated into English by Prof. Harvey Gibson and published by the Oxford University Press in 1907. It gained for Jost a great reputation in England, as is shown by his election as a foreign member of the Linnean Society in 1932 and of the Royal Society in 1936. He visited England on several occasions and was present at the International Botanical Congress in Cambridge in 1930. He was personally known to many British botanists, and was esteemed by them for his intellectual gifts. He was endeared to his English friends by his modest bearing and his courteous and friendly manner. He has left an affectionate memory among all who knew him.

He is survived by his wife, who smoothed for him the difficulties of his declining years, and by two daughters. F. E. Weiss.

Arthur Smith (1869–1947) died at Beccles, Suffolk, on 15 April 1947. Mr. Smith retired from the curatorship of the Lincoln City and County Museum in 1934. He entered the museum profession at the age of 21, when he was

appointed sub-curator of the collections of the Grimsby and District Antiquarian and Naturalists' Society. A few years later he became its secretary and museum curator, which offices he held until his appointment in 1906 as the first curator of the Lincoln Museum. During his service in Grimsby he was also teacher of botany at the Wintringham Secondary School and was elected a fellow of the Entomological and Linnean Societies. At Lincoln Mr. Smith found ample opportunity for the foresight and enthusiasm that had characterized his work at Grimsby. He came to an empty building, and the splendidly equipped, skilfully-displayed, neatly-labelled museum in the Greyfriars is a worthy tribute to his distinguished service in the city. Although his interest was at first in the natural sciences, he soon became a very competent archaeologist and his pioneer research work in the city and county formed a foundation for subsequent investigations. A prolific writer, his contributions to scientific journals and the press did much to draw attention to the educational value of museums and to the wealth and interest of their collections. He was always ahead of his time in display-technique, which was a tribute to his ingenuity, skill, and vision. He was a pioneer in the use of the simplified habitat group which has received so much attention in recent years. He was on several occasions elected a member of the Council of the Museums Association and in 1922 its vice-president. As secretary of the Lincolnshire Naturalists' Union and editor of its Transactions from 1905–1934, he was responsible for promoting the study of natural history in Lincolnshire. Its Transactions are a tribute to the vast amount of work he accomplished, for in addition to his work as editor, many extensive studies appear under his name. He was President of the Union in 1934.

F. T. Baker.

Cecil Norman was born on 12 September 1872, at his parents' home in Halkin Street, London. He was the fourth son of Henry John Norman, Esq., a banker, and his wife Anne (née Coote). He was brought up at Gadsden, Hayes, Kent, in the country, with visits to London, where his parents had a house at 21 Cadogan Square, and to his mother's relations at Mount Coote, Killmallock, Co. Limerick, in Ireland. He entered Harrow School in September 1887, where he remained till July 1891.

After studying at the Royal Agricultural College, Cirencester, he worked for a short time on the Stock Exchange as assistant to a friend, and later for the Charity Organization, now called the Family Welfare Association. In the Boer War he served in the Transvaal with Paget's Horse, and afterwards took up farming in Wiltshire. He had a tendency to asthma and the place aggravated this, so after a winter in the West Indies, he went into partnership with a cousin, Mr. G. Bonham-Carter, with whom he farmed Beufre Farm, Beaulieu, in the New Forest—a mixed farm of 340 acres—from 1907 to 1912, when, as the farm was not financially successful, it was given up; and he then came to live with his mother and sister in London.

In the war of 1914–19, Norman joined one of the Sportsmen's Battalions of the Rifle Brigade, from which he retired with the rank of Captain. His service was spent in the Andaman Islands and Burma. In Burma he made the acquaintance of Mr. Alexander Rodger, then Conservator of Forests. Though as a boy he was interested in gardening, he knew all wild flowers which were at all common, and could identify most birds from their notes, it was through his friendship with Rodger that he first became interested in the scientific aspects of botany.

After the war, when he was living with his sister in London at 55 Eccleston Square, S.W. 1, and his connection with the botanical department of the British Museum (Natural History) started in 1920, he presented a small collection of European plants from the Auvergne. About this time he began to come regularly to the Museum as a voluntary worker, and very soon started

to devote his attention to the Umbelliferae, on which he published his first paper in 1922. Papers, twenty-two in all, followed in rapid succession till 1940, mainly on the Umbelliferae, but his range gradually extended to the Araliaceae, Cucurbitaceae and Asclepiadaceae. In addition to some naming of large collections, especially from Arabia and the West Indies, which did not appear in print, he made a number of small collections—77 Algerian plants in 1922, 261 specimens of West Indian plants from Jamaica and Cayman Brac in 1924, and 90 from Cyprus in 1930, were incorporated in the collections of the Museum.

Cecil Norman's botanical work was a fine example of a contribution made by a man starting late in life with little botanical training. It was achieved by specialization within a comparatively small field. Eventually his work on the Umbelliferae became known abroad, and collections were sent to him from foreign museums for study and identification. He was elected F.L.S. in 1923 and was a member of Governing Council of the Empire Forestry Association.

Cecil Norman remained a bachelor, but his friendliness and youthful outlook won him many friends to whom he will be a great loss. Besides natural history his interests included cricket, he was often at Lords or the Oval; fly fishing, which took him to Dorchester in the may-fly season; and forestry, the latter mainly theoretical, though he was proud of the cricket-bat willows which he grew on his estate at Orpington.

Norman left Eccleston Square in 1940 and he went to live at Meadow View, Ickham, near Canterbury, where he died suddenly from heart failure while returning from a long day's bird watching on the river with a gamekeeper, on 2 April 1947. A. H. G. Alston.

The Lady **Isabel Browne**, who died on 8 June 1947, will be missed deeply, both as a botanist and as a friend. She had a special regard for the Linnean Society, of which she became a Fellow in 1909; from time to time, after consultation with the Librarian, she presented books which she found were absent from our shelves.

Born in London on 6 November 1881, Isabel Mary Peyronnet Browne was one of the twin daughters of the third Marquess of Sligo, by his third wife, a daughter of Baron (afterwards Vicomte) Jules de Peyronnet. From the time that Lady Isabel and Lady Mary were five years old, their father was a semi-invalid, and it was thus their mother whose influence upon their minds and characters was paramount. Lady Sligo had a vivid and charming personality, and was celebrated for her gallic wit; markedly individual herself, she encouraged mental independence in her children. Her feeling for literature was ardent, and in her youth she, with her sisters, had carried through the considerable task of translating several of Trollope's novels into French. She read Shakespeare to her twin daughters from the time they were seven or eight years old; at a later date Lady Isabel developed a passion for Milton, which endured throughout her life. Her taste, even in childhood, was for reading of an unusually solid kind; when only about nine or ten, she was capable of being absorbed, for hours together, in that massive work, Lamartine's *Histoire des Girondins*. Before she was nineteen, she had immersed herself in French history and politics of the post-1815 period, and this interest was a permanent one. She and her mother never let pass the anniversary of Napoléon III's *coup d'état*—which Lady Sligo could remember, though faintly—without a smiling glance at one another, and the words, "Ah! le 2 décembre". Lady Mary Browne, to whom I am indebted for much of the material for this notice, has suggested that Lady Isabel's unusual capacity for weighing evidence may have been, in part, an inheritance from the galaxy of lawyers among her forbears, for nearly all the men of her mother's family were of this profession; her great-grandfather, Pierre Denis, Comte de Peyronnet, held various judicial posts, and was Garde des Sceaux in the last Cabinet of Charles X of France.

Another source of intellectual power came into the family through the marriage of Lady Isabel's grandfather, the Baron de Peyronnet, to Frances Whitfield, an Englishwoman of remarkable gifts. She was bilingual, and, under the pseudonym of 'Horace', or 'Horace de Lagardie', she wrote on French politics and literature in the *Revue Nationale*, the *Journal des Débats*, and the *Edinburgh* and the *Fortnightly Reviews*. In a journal of the period, she carried on a controversy as to whether philistinism existed in France, with Matthew Arnold, who once said, in talking to her daughter, 'I wish Madame de Peyronnet, who knows so many literary people, could find out who that very clever fellow "Horace" is'. In way of life there was a striking parallelism between Lady Isabel and her grandmother, for, just as Madame de Peyronnet lived like any other intelligent society woman in Paris, while accomplishing much serious writing, so Lady Isabel, in her younger days, carried on social and scientific existence concurrently, going to dances and parties in the evenings, playing tennis or hockey in the afternoons, but devoting her mornings steadily to botany. In any conflict, however, between her work and human duties, she always put the latter first. In the 1914–18 war, she devoted herself, in one of the London offices of the Red Cross, to tracing soldiers who were wounded and missing in Flanders; for this work she received the O.B.E. In the second world war, she and her sister undertook, in their home in Surrey, the care of a group of little evacuees from London; this work gave scope for the special affection which it was her nature to arouse in children, and which she returned with warmth.

One of the most effective intellectual influences in Lady Isabel's life, from her childhood onwards, was the friendship of her first cousin, Mr. Harold Russell, who was some ten years her senior, and died in 1925. He shared her French ancestry, and with it her concern with France in various aspects, while, as a good German scholar, he helped her appreciation of German prose literature. Moreover, both he and his wife, Lady Victoria Russell, who was one of her closest friends, in every way encouraged and stimulated her desire to work at botany. The seeds of scientific interest had, indeed, been sown early, for, on their mother's initiative, the twin sisters, from the time the were nine years old, received weekly lessons in botany, zoology, geology, and a little astronomy, from a tutor, Mr. W. F. Gwinnell. It was he who, on Lady Isabel's fifteenth birthday, gave her a copy of Dr. D. H. Scott's *Structural Botany* (*Flowering Plants*); this was probably her first introduction to the writer who influenced her more than any other botanist. The crucial phase in her scientific development arrived when she attended certain special lectures which he gave at University College, London, in the early nineteen hundreds, on the subject of fossil botany; it was his lectures which first opened to her the field which she was to make her own. She was greatly delighted when, in 1916, she was invited to collaborate with him in a book, and it was a correspondingly bitter disappointment that—primarily on account of her conscientious determination not to sacrifice her war work—the project failed to materialize. Soon after hearing Dr. Scott's lectures on the Lycopsida, Lady Isabel began—at the suggestion of Miss Flora Russell, Harold Russell's sister—to read regularly in the Botanical Department of the British Museum (Nat. Hist.), concentrating on the structure and phylogenetic relations of the various groups of Vascular Cryptogams. After some years of this special reading, she put together a critical résumé of her studies as a book. The publisher to whom she sent it, submitted it to Dr. Scott, who did not advise its appearance in book form, but suggested that the more general chapters might be used as an essay in some scientific journal. Mr. (now Professor) A. G. Tansley, who was consulted, accepted it for the *New Phytologist* (1, in the list appended), giving it practically the status of a book by issuing it subsequently

as one of his *New Phytologist Reprints*. This memoir was a startling achievement on the part of a writer without formal academic training, who had, moreover, never done laboratory work. Lady Isabel seemed able, simply by reading independently, and applying her critical faculty, to visualize facts and judge theories, whether or no she had been concerned in actual practice with the plants under discussion ; but at this stage of her career it became clear that access to a different field of experience was necessary to supplement the purely mental range, which she had extended so far, and it was suggested to her by her friend, Miss Lettice Digby, then doing cytological research with Professor J. B. Farmer, that she might try working in a laboratory, where she would have an opportunity to handle the material in which she was interested. In the autumn of 1907 she acted on this advice, entering Professor F. W. Oliver's Department at University College, where it fell to me—then a junior member of the staff—to give her individual teaching in botanical technique throughout that Session. She took great pleasure in microtome work, linking it up with the appreciation of pictures which she inherited from her father, who had been a discriminating collector. In a letter mentioning the seven visits which she had paid to the exhibition of Flemish pictures at Burlington House in 1927, she wrote, ' I'm sure that if a Flemish painter had been forbidden to paint as an expiation for some great crime, he would find consolation in preparing a well stained set of serial sections '. Having once mastered laboratory methods, she was in a position to begin research of her own, which she continued for many years in the Botanical Department of University College, to which her scientific books and preparations have now, by her wish, been given. The subject which she selected initially, and to which she remained constant, was a detailed investigation of the structure of *Equisetum*. This work gave her a most useful base-line of perceptual knowledge, to which to relate her broader studies. Her chosen genus must have attracted her at an early stage, for the habitual description to her family of her occupation at the Natural History Museum was, ' reading about horsetails '. A point which specially appealed to her was probably their ancientness of lineage, for on one occasion, when I was trying to uphold the claims of the flowering plants, as subjects for research, she dismissed these relatively modern creatures as ' upstarts '. The results of her work on *Equisetum* were published in a series of papers over a period of thirty years in the *Annals of Botany* (2, 3, 4, 5, 7, 9, 15, 19), as well as in the *Botanical Gazette* (8, 11, 18), and the *New Phytologist* (6). She never generalized about structure from a few sections, but her descriptions of cone anatomy were based on complete microtome series through the distal regions of fertile shoots. This work was exceedingly laborious ; for instance, her account (4) of *Equisetum maximum* Lam. (*E. Telmateia* Ehr.) includes a reconstruction of the vascular system of a cone, which required for its representation a diagram nearly 2 ft. 6 in. in length, in order to show the behaviour of each individual strand.

Among the conclusions to which her work led her was that the sporangiophores of *Equisetum* are whole appendages, and not lobes of a sporophyll or leaf (2). She argued, moreover, that the annulus is a reduced whorl of leaves, and that the sporangiferous annulus is derivative (5). She had an exceptional power of holding her judgment in suspense, and, on the question of whether the central cylinder of *Equisetum* originally was in the form of separate unbranched strands, or of a siphonostele, she consistently maintained an open mind (15, 19).

To her work on modern Equisetums, Lady Isabel added an exhaustive study of such of Renault's sections of *Calamostachys* as are preserved at the Muséum d'Histoire Naturelle at Paris, or are in the possession of the Société d'Histoire Naturelle d'Autun, of which Renault was founder and President. Her critical notes were published in the *Annals of Botany* (12), the *Bulletin du Mus. d'Hist. Nat.* (10), and the *New Phytologist* (13).

Besides detailed research work of this kind, Lady Isabel produced several comparative papers covering the entire field of the Pteridophyta. We have already alluded to the first of these (1), in which she considered the phylogeny and interrelationships of all the phyla then reckoned to belong to the group. About a quarter of a century later, a sequel to this memoir dealt with the significance of the recently discovered Noeggerathiales in connexion with the broader classification of the Pteridophyta (16). Still later (17), she discussed the effect, upon theories of the interrelationships of the Vascular Cryptogams, of the newly acquired information about the Rhyniaceae and other Psilophytales. These general papers are all characterized by a balanced fairness of critical judgment, as well as by an acute sense of logic, traceable, perhaps, to Lady Isabel's French ancestry; but they are not easy reading. Whether she was, in a letter, dissecting the minutiae of French politics, or, in a scientific journal, disentangling some recondite feature in the structure of an obscure fossil, she never made concessions to ignorance, because her extreme modesty led her to assume that every one else was at least as well informed as she was herself. Her work was thus always of the type that appeals mainly to the specialist. On comparing what she wrote at different periods, one finds indications that her clear-cut phylogenetic outlook, characteristic of the early twentieth century, was, in course of time, modified by the recognition that modern research had shown her problems to be more baffling and bewildering than they had at first appeared. Nevertheless her standpoint remained, throughout her life, convincedly and avowedly phylogenetic. She was one of those rare people who are ready to discuss theoretic questions by letter; a few of her words from such a discussion may perhaps be quoted as summarizing her point of view. I had confessed to a certain scepticism about the process of evolution, as understood by those who treat this process as a framework for theories of ancestral derivation. She replied (19 August 1941) that she regarded the phylogenetic method, 'if carefully and honestly used', as offering 'a means of obtaining an insight into origins', while she criticized my 'abstract conception of morphology' as increasing 'the amount of distortion from reality'. Exact truth to her own delicately but strongly defined picture of reality, was, indeed, the keynote of her work.

AGNES ARBER.

List of papers by ISABEL M. P. BROWNE.

1. The Phylogeny and Inter-relationships of the Pteridophyta. *New Phyt.*, **7**, 1908, pp. 93–113, 150–166, 181–197, 230–253; **8**, 1909, pp. 13–31, 51–72. Reprinted, 1909, as *New Phytologist Reprints*, No. 3.
2. Contributions to our Knowledge of the Anatomy of the Cone and Fertile Stem of Equisetum. *Ann. Bot.*, **26**, 1912, pp. 663–703.
3. [Cone and Fertile Stem of Equisetum.] A Correction. *Ibid.*, **27**, 1913, p. 168.
4. A Second Contribution to our Knowledge of the Anatomy of the Cone and Fertile Stem of Equisetum. *Ibid.*, **29**, 1915, pp. 231–264.
5. A Third Contribution to our Knowledge of the Anatomy of the Cone and Fertile Stem of Equisetum. *Ibid.*, **34**, 1920, pp. 237–263.
6. Phylogenetic Considerations on the Internodal Vascular Strands of Equisetum. *New Phyt.*, **19**, 1920, pp. 11–25.
7. A Fourth Contribution to our Knowledge of the Anatomy of the Cone and Fertile Stem of Equisetum. *Ann. Bot.*, **35**, 1921, pp. 427–456.
8. Anatomy of *Equisetum giganteum*. *Bot. Gaz.*, **73**, 1922, pp. 447–468.
9. Anomalous Traces in the Cone of *Equisetum maximum* Lam. *Ann. Bot.*, **37**, 1923, pp. 595–604.
10. Note sur les Bractées de *Palaeostachya gracilis* Ren. *Bull. du Mus. d'Hist. nat.*, **29**, 1923, pp. 541–542.
11. Structure of the Rhizome of *Equisetum giganteum*. *Bot. Gaz.*, **80**, 1925. pp. 48–62.
12. Notes on the Cones of the *Calamostachys*-Type in the Renault and Roche Collections. *Ann. Bot.*, **39**, 1925, pp. 313–358.
13. A Note on *Calamostachys tuberculata* Stgb. *New Phyt.*, **24**, 1925, pp. 305–308.
14. A New Theory of the Morphology of the Calamarian Cone. *Ann. Bot.*, **41**, 1926, pp. 301–320.

15. A Fifth Contribution to our Knowledge of the Anatomy of the Cone and Fertile Stem of Equisetum. *Ibid.*, **47**, 1933, pp. 459–475.
16. The Noeggerathiae and Tingiae: The Effects of their Recognition upon the Classification of the Pteridophyta: An Essay and a Review. *New Phyt.*, **32**, 1933, pp pp. 344–358.
17. Some views on the morphology and phylogeny of the leafy vascular sporophyte. *Bot. Rev.*, **1**, 1935, pp. 383–404, 427–447.
18. Anatomy of the Aerial Axes of *Equisetum kansanum*. *Bot. Gaz.*, **101**, 1939, pp. 35–50.
19. A Sixth Contribution to our Knowledge of the Anatomy of the Cone and Fertile Stem of Equisetum. *Ann. Bot.*, N.S., **5**, 1941, pp. 425–453.

Thomas Leonard Lancaster (1888–1945) was born in Karori, Wellington, New Zealand, and after passing through the Palmerston North High School, he attended the Victoria University College. In 1910 he won the Sir George Grey scholarship, having 'pursued successfully a science course of an advanced standard'. His thesis on the fungi of the New Zealand epiphytic orchids was published in 1911. Appointed in 1913 as Demonstrator in Botany at the Auckland University College, he gave thirty-two years' service to the cause of botanical education, advancing to the position of Associate Professor. He took his M.Sc. degree in 1923, and was elected a Fellow of the Linnean Society, London, in 1929.

Frail in health, he gave devoted attention to his teaching duties, but was unable to prosecute much original research. Many students, who have since becoming distinguished in botanical research, look back with respect and esteem on the foundations laid by their teacher. One of them has written, 'in lecture room and laboratory he made a point of drawing his illustrated material from local plants in order to bridge the gap betweed imported text-books and the students' personal experience and observation.'

Lancaster always endeavoured to give of his best to the public as well as the student. He gave valuable service to the Royal New Zealand Institute of Horticulture, established an excellent arboreum in the College grounds, encouraged the use of indigenous plants in his capacity as Honorary Botanist to the City of Auckland, and was Vice-President of the Auckland Botanical Society from its inception. His death in April 1945 removed a true plant-lover from active service, but his memory will always remain green. H. H. ALLAN.

Ralph Ellis (1908–1945), the son of Ralph Ellis and his wife, Elizabeth (Warder) Ellis, was born on 15 June 1908, at Jericho, Long Island, New York, and died on 17 December 1945, at Colusa, California. The body was cremated on 22 December 1945, at Berkeley, California. Mr. Ellis is survived by his mother and his wife, Irene (Sibell) and his first wife from whom he was divorced. He had no children. Death occurred from pneumonia, and the body was not discovered until approximately two days later in the hotel room which he made his headquarters on a week's excursion to hunt wild fowl in the Sacramento Valley, near Colusa.

As an only child, with delicate health, born to older than average parents of substantial means, Mr. Ellis received his early education from private tutors. The terminal part of his preparatory school work was done at the Cora Williams School in Berkeley, California, from which he went to the University of California at Berkeley for only a few weeks before he withdrew to devote his attention to natural history pursuits. With the late Dr. Glover M. Allen, of the Museum of Comparative Zoology at Harvard College, in 1932, he collected natural history materials in Australia, and, in 1937, spent a year in London selecting items for his ornithological library.

Early in boyhood, Mr. Ellis displayed a keen interest in ornithology and in his teens began forming a collection, first of mounted birds and later of study specimens. Under the tutelage especially of Mr. Adrey E. Borell, he planned his collecting activities so as to contribute to the better knowledge

of the vertebrate fauna of western North America. For example, he made, and with assistance from his parents financed the making of extensive collections of both birds and mammals from the Ruby Mountains region of north-eastern Nevada, and later the Seven Devils Mountains region of west-central Idaho. In the year 1934, as junior author with Borell, Mr. Ellis published : ' Mammals of the Ruby Mountains region of north-eastern Nevada ', *Journ. Mamm.* **15**, pp. 12–44, 6 pls., 1 fig. ; and ' Mammals found near Jarbridge, Elko County, Nevada ', *Journ. Mamm.*, **15**, pp. 72–73. His mammal collections are further reported upon in *The Recent Mammals of Idaho*, by W. B. Davis, The Caxton Printers, Ltd., Caldwell, Idaho, 1939, and *Mammals of Nevada* by E. R. Hall, University of California Press, Berkeley, 1936.

Beginning in his twenties, Mr. Ellis took an interest in ornithological literature and built up what may be the finest private natural history library in North America, comprising as it does approximately 65,000 volumes, including most of the rare works on ornithology and complete sets of journals and serials containing articles on birds. Subsequently he interested himself also in bibliography, and at the time of his death was adding published works on this subject to his library. To make room for his rapidly growing library in his mother's home on Ridge Road in Berkeley, California, Mr. Ellis loaned first his collection of 2700 mammals and a few years later his larger collection of birds to the Museum of Vertebrate Zoology at the University of California. In the summer of 1944 his collection of mammals was transferred to the Museum of Natural History, University of Kansas, and in the spring of 1945, he gave it outright to that institution. At the same time, 1945, on a loan basis, he deposited his library at the University of Kansas, and until a few weeks before his death was engaged in unpacking and arranging his books there. His will provided that the collection of birds should pass to the University of California and his library to the University of Kansas. Mr. Ellis was interested in the welfare of all societies which published material relating to ornithology and was a life member and patron of many of them, and had death not claimed him at a relatively early age, he probably would have realized his intention of aiding in the publication of much biographical and bibliographical material. He was elected a Fellow of the Linnean Society of London on 26 November 1936. E. R. HALL.

Professor **George Matthai**, M.A., Sc.D. (Cantab.), F.R.S.E., F.N.I., a Fellow of this Society, was one of the most eminent among the relatively small group of Indians, who have achieved an international reputation in Zoology, and his sudden death in Cambridge on 25 June last is deeply regretted—all the more so since at the present time, when the new India is striving to establish a stable Government and develop its resources unaided by foreign personnel, there is a great need for the services of every one of her most able and experienced scientists.

Matthai was a member of a cultured and intellectual family of the Ancient Syrian Church of Malabar, India, and he was born in November 1887 in Calicut, where his father, who was a member of the Madras Educational Service, had settled after leaving Travancore. He received his early school training at the Zamorin's High School and Zamorin's College, Calicut, and then proceeded to the Christian College, Madras, for his University training. Having been born and living as he did by the sea at an important Indian port, it was but natural that he should early develop an interest in zoology and more particularly in Marine zoology ; and during his time at Madras University he began to show his interest in, and aptitude for, this branch of science, for in 1907 he took his B.A. degree with 1st Class Honours in Zoology and two years later was awarded 2nd Class Honours for his M.A. degree. For the next

year he continued at the Christian College, Madras, as a Lecturer in Zoology, but in 1911 he came to England and was admitted to Cambridge University as an Advanced Student and joined Emmanuel College, where he was a contemporary of another of India's most famous scientists, Professor B. Sahni, F.R.S.

At Cambridge Matthai came under the influence of the late Professor J. Stanley Gardiner, F.R.S., who had in 1899–1900 carried out an expedition to the coral islands of the Maldive and Laccadive Archipelagoes: in those days an Advanced Student at Cambridge had to carry out a piece of research work under the guidance and supervision of the Professor, and it was thus only natural that Matthai should take as his subject 'The Comparative Anatomy of Astraeid Corals', in which Stanley Gardiner was himself keenly interested. In 1913 his Thesis was approved and Matthai was given the degree of B.A. of Cambridge and was also awarded a grant from the Balfour Fund to enable him to continue his researches. At a very early stage of his work Matthai had realized the very great importance of the study of the soft parts of the corals, as well as of the hard corallum, and in 1914 he published in the Transactions of this Society a most important paper on 'The Histology of the Astraeid Corals'. In the same year he was awarded a Mackinnon Research Studentship by the Royal Society of London and this was renewed in 1915 and again in 1916. With this financial assistance he was able to visit the great Museums of Paris, Berlin, Vienna and Copenhagen, as well as the British Museum (Nat. Hist.), London and the Hunterian Museum, Glasgow, in order to study the coral collections of these Institutions, and he also visited America to study the collections of the U.S. National Museum, Washington, the American Museum, New York, and those of Harvard and Yale Universities. During his stay in America he was able to visit Tortugas in the Gulf of Mexico and Bermuda, in both of which areas he made his own collection of carefully preserved corals, as well as studying the living corals *in situ* on the reefs.

In 1918 Matthai returned to India on being appointed Professor of Zoology in the Government College, Lahore, and in 1920 he became Professor in the Punjab University: he was an excellent and stimulating lecturer and like his own teacher, Stanley Gardiner, he believed in lecturing on 'problems', in order to induce his students to think for themselves, rather than in giving them a stereotyped presentation of a succession of Phyla in the Animal Kingdom. So far as his Academic duties permitted he continued his study of Corals and in 1924 he published his 'Report on the Madreporarian Corals in the Collection of the Indian Museum, Calcutta' (*Mem. Ind. Mus.* vol. viii). In 1924–25 Matthai was again in England, working in the British Museum, London, and completing his very important paper on 'Colony formation in Astraeid Corals', which was published by the Royal Society (*Phil. Trans.*, vol. 214, 1926). In this paper Matthai points out that 'A correct idea of the internal anatomy of Polyps, and of the mesenterial relationships of adjacent polyps can be gained only by studying entire series of sections'; but few realize the immense amount of work that is necessary for the preparation of even a single diagram, entailing as it does the preparation and careful examination of hundreds of serial sections. As a result of his extremely careful work Matthai was able to prove that 'colony formation is by extra-tentacular or intra-tentacular budding only, fissure of the stomodaeum never occurring'. He also considerably modified the classification of the corals and greatly reduced the number of so-called 'species'. At first his conclusions met with some opposition and scepticism from older workers, but eventually it became recognized that he was right and his views were accepted and endorsed by most of the experts. During his leave from India in 1925 he married Mary Chandy, daughter of the late Mr. C. Chandy of the Mysore Civil Service and later Vice-Chancellor of the University of Mysore: she died in 1931, leaving one son, Ariel, and in 1935

Matthai married again, his second wife being Mmlle Rosalinda Hedwig of Switzerland, who survives him.

In 1927–28 Matthai again visited England and completed his great *Monograph on the Recent Meandroid Astraeidae*, which was published by the British Museum as volume viii. of the ' Catalogue of the Madreporarian Corals in the British Museum '.

In 1921 Matthai was elected a Fellow of the Zoological Society of London and in the following year he became a Fellow of this Society. In 1928 he was elected a Fellow of the Royal Society of Edinburgh and in 1929 the University of Cambridge conferred upon him the degree of Doctor of Science.

In India Matthai took a leading part in zoological affairs. He was twice President of the Zoology Section of the Indian Science Congress, first in 1923 and again at the Silver Jubilee Meeting in 1938. He was one of the Foundation Fellows of the National Institute of Sciences of India and he served on the Zoological Committee of the Institute from 1937 to 1940. During the last years of his professorship he was also Dean of the University and did much to stimulate zoological research in the Punjab. He retired from his professorship under the age-limit rule in 1943 and as a mark of their appreciation of the work that he had done during his term of office the Punjab University conferred upon him the title of ' Emeritus Professor '. After his retirement he continued to carry on his research work and for a few months in 1946 he acted as Director of the Zoological Research Laboratory of Madras University. In May 1946 he again came to Cambridge to continue the work on several papers, the preparation of which had been interrupted by the War and negotiations were in progress to obtain for him a grant from the Royal Society of London that would enable him to continue his work for some years, and prepare a second great Monograph that would deal with the Fungiid Corals. His tragic death has robbed Zoology of one of its greatest experts on the Corals and especially on the systematic and taxonomy of this group, and the Society extends its deepest sympathy to his widow and son.

R. B. Seymour Sewell.

BENEFACTIONS

List *in accordance with Bye-Laws, Chap.* 17, *Sect.* 1. *of all Donations of the amount or value of Twenty pounds and upwards, received during the past five years.*

1943

Rockefeller Foundation : Donation in aid of publications, £100.
The Royal Society : Grant-in-aid of publications, £100.

1944

Rockefeller Foundation : Donation in aid of publications, £150.
The Royal Society : Grant-in-aid of publications, £50.
Mr. J. Insch : Donation to be used for the repair and binding of his collection of books on Tea, to be bequeathed to the Society, £100.
Gonville and Caius College : Donation in aid of the publication of Dr. V. J. Chapman's paper on the Vegetation of Jamaica, £50.
Lt.-Col. F. R. S. Balfour, C.V.O., J.P., D.L. : Transcription of the Journal of Archibald Menzies (1754–1842), bound in half leather ; 5 vols. quarto.

1945

The late Mr. H. N. Dixon ; Legacy for general purposes, £100.
The Royal Society : Grant-in-aid of publications, £650.
Rockefeller Foundation : Donation in aid of publications, £200.

1946

The Royal Society : Grant-in-aid of publications, £800.

1947

The Royal Society : Grant-in-aid of publications, £750.
Anonymous Donor : Towards the reorganization of the Library, £100 ; and two mahogany bookshelves.
Mr. Reginald L. Hine, F.S.A. : Manuscript botanical note-book written by Thomas Lawson in 1676–77.

ADDITIONS AND DONATIONS TO THE LIBRARY.

1946–47

Note.—Names of donors are given in square brackets. Separate copies of papers which are included in periodicals received by the Library are no longer catalogued.

Alston, A. H. G. The Kandy Flora. Pp. xvii+109. 8vo. (Ceylon Government Press), *Colombo*, 1938. [Author.]

Armattoe, R. E. G. The Golden Age of West African Civilization. Pp. 96. 8vo. *Londonderry*, 1946. [Author.]

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Matthew, W. D. Climate and Evolution. Ed. 2. Pp. xi+223. 8vo. *New York*, 1939.

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Molisch, Hans. Populäre biologische vorträge. Ed. 2. Pp. 306. 8vo. *Jena*, 1922. [Prof. F. E. Weiss.]

Moulton, F. R., *edited by.* The migration and conservation of Salmon. Pp. 106. 8vo. *Lancaster*, 1939.

Muenscher, W. C. Aquatic plants of the United States. Pp. x+374. 8vo. *Ithaca*, 1944.

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Parker, Eric. Oddities of Natural History. Ed. 2. Pp. 228. 8vo. *London*, 1943.
Phillip, Arthur. The voyage of Governor Phillip to Botany Bay; with an account of the establishment of the Colonies of Port Jackson and Norfolk Island. . . . 4to. *London*, 1789. Pp. 6, xvi, xiv, 298, lxxiv; 54 pls. [Dr. G. RUDORF.]
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Page 26, 9 lines from bottom—*for* Peddiaeae *read* Peddieae.
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